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PROCEEDINGS

OF THE

PHILOSOPHICAL SOCIETY

OF GLASGOW.

PROCEEDINGS

OF THE

PHILOSOPHICAL SOCIETY

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PROCEEDINGS

OF THE

PHILOSOPHICAL SOCIETY OF GLASGOW.

NINETY-SEVENTH SESSION.

I.—*Sanitation by Compulsion.*

By Gilbert Thomson, M.A., C.E., Mem. San. Inst., President of the Sanitary and Social Economy Section of the Society; Ex-President of the Sanitary Association of Scotland.

[Read before the Society, 1st November, 1899.]

The liberty of the individual to do what is right in his own eyes is not only subject to many limitations, but the number and stringency of these are steadily increasing. Nothing perhaps is responsible for so much of this increase as sanitation.

Nor is the reason far to seek. The dwelling, the personal habits, and the sanitary or insanitary surroundings of Robinson Crusoe, in the early days of his sojourn in the famous island, were of absolutely no importance to the remainder of the human race. This state of affairs, strictly speaking, came to an end on the appearance of the man Friday; and when, further on in the story, the occupants of the island became considerably more numerous, there immediately arose a need, probably unrecognised, for some sanitary supervision.

Although in dealing with our own country we can scarcely go back to such a primitive state of affairs, we have still to a certain extent an analogy. The country as a whole, and the large towns in particular, are increasing in population at a rate which presents many definite dangers. What might in a small community be done with comparative safety, becomes more dangerous in proportion as the population is increased, and therefore if we are even to maintain our sanitary position much has to be done. But we cannot be content with maintaining our position, for the increase of sanitary knowledge has on the one hand shown us that our position is a bad one, and has on the other hand put into our possession many new weapons for the battle with disease. Sanitarians, therefore, are earnest in their desire that, whether by free will or by compulsion, these weapons should be used to the full.

Even if we start with the assumption that every individual is anxious to do his duty by the public, there would still be ample room for official interference. Ignorance and prejudice have to be reckoned with, and these, even when coupled with the best intentions, do not make for the public safety. One man has conscientious objections to vaccination; another man, or perhaps more frequently woman, believes conscientiously that she is doing a good turn to the children of her neighbour by allowing them to catch infection from a mild case of scarlet fever; while I have met a man who assured me (I presume conscientiously) that he considered the water supply of London preferable to that of Glasgow. Besides the wilfully blind, there are multitudes who would willingly do what was best, if they only were sure how; and for them compulsory enactments are like the finger-posts on a country road —they point out the way to those who are anxious to walk in it.

It would be impossible, even if it were desirable, for me to take up in detail the almost innumerable points at which we are hemmed in by sanitary regulations. "The liberty of the subject" is a principle which we rightly regard as sacred; but, as great principles have to yield to greater, even this has to give way when the liberty would result in danger to the community. The community has assumed the right, which is practically unquestioned, to dictate to any of its members how he is to conduct his most private affairs, if these trench on the public well-being.

I would be the last to complain of this state of affairs. Although I have not yet attained the dignity of a hoary head and a venerable age, still I am old enough, and have been actively engaged in sanitary work long enough, to have seen as common everyday sights practically all the horrors from which these regulations seek to protect us. I have seen, I suppose, almost every variety of scamped sanitary work, which the ingenuity, or stupidity, or cupidity of builder or plumber or designer ever devised. I have occupied a bedroom with several reeking ashpits as the foreground of its view, to say nothing of box-beds in various parts of the country; I have as a boy gone for water to wells of high local reputation, which would not be attractive in the light of later knowledge; and I have amused myself, in the amateur engineering of childhood, by building dams across, and generally "paidling" in, a stream which I would now have no difficulty in recognising as a common sewer. I have felt the evils, and appreciate the need for a vigorous remedy. If therefore I say anything which looks like an objection to the remedy, I would ask you to put it down to faulty expression. Nothing is further from my thought or desire. Some details I may criticise; I most thoroughly believe in the principle.

It is said that George Stephenson once asked a friend, as they stood together watching the swift passage of a train, what he thought made the engine go. The friend suggested first the driver, next the coal, but at last they got back to the rays of the sun, stored in the coal countless ages ago. What is the power on which we depend to drive our sanitary engines? We have the skill and experience of a highly qualified sanitary staff; we have the voluntary but arduous labours of Town and County Councils; and behind all these we have the majesty of Parliament, and the strong arm of the law. But still further back, all our power depends on public opinion. Without this to back us our progress will be slow and unsatisfactory, and our results will be insignificant. It is therefore of the first importance that, on the one hand, public opinion should be educated up to support every reasonable sanitary requirement, and that on the other hand, exceptional care should be taken to avoid anything in the way of compulsion, or even of compulsory powers, that to the general public will appear to be oppressive. Fortunately, although each member of the public is apt to resent coercion when applied to his own case, he takes a much wider view when somebody else is the object of it, always provided that the process is not such as to offend the general sense of fair play.

By way of being somewhat more definite and precise, in a subject which is not capable of precise treatment in its general aspects, I propose to refer to two typical and meantime prominent aspects of sanitary compulsion, differing widely in their nature and application. The first of these is River Pollution with respect to sewage; the second is Building Regulations. The first is a broad question, and I will refer to it broadly. The second is full of detail, and I will confine myself to some few of these details.

Any delay which has taken place in dealing with the question of river pollution is not due to the want of agreement as to general principles. The need for action is admitted not only by those who have already moved in the matter, but by many who are still in the position of having done nothing. The delay is due to the natural hesitation of ratepayers' representatives to face a large expenditure, and the equally natural desire to make sure that this money is spent to the best advantage. Since my distinguished predecessor in the chair of the Sanitary and Social Economy Section gave as his Presidential address the results of an exhaustive inquiry into the condition of Scottish rivers, we have moved very slowly as judged by results, but much more rapidly as judged by the formation of public opinion. We see, for example, little change in the condition of the Clyde, but we know that operations are in progress which we hope and believe will remove from Glasgow at least the reproach of continued pollution. Further afield, while few places have actually carried out works of sewage purification, there is all around an earnest desire and enquiry for the best method of treatment. Public opinion will now undoubtedly back up the action of any of our governing bodies, from the Local Government Board downward, in insisting on the effectual treatment of sewage before it is allowed to enter, at all events, our inland streams. I do not propose to discuss the merits of the various rival systems. Of these we have a number, any one of which may, from the river pollution point of view, be accepted as a solution of the problem. We are at present in the very curious position, that perhaps the chief obstacle in the way of progress is the effort which the Government has made to assist it. By the appointment of a strong Commission, whose report will necessarily carry great weight, we have the promise, at a time which is unfortunately somewhat indefinite, of an authoritative and impartial review of the numerous competing systems and their results. In spite of the expressed desire of the Commissioners that no Local Authority should delay action by waiting for their report, it is scarcely surprising that Local Authorities should hesitate to commit themselves to schemes which may or may not receive this official approval. I am not a prophet, nor have I the slightest clue to the inner workings of the Commission, but personally I would be surprised were its report such as to indicate definitely that any one system had such exceptional merits as to mark it for general adoption. The local conditions will still be the determining factor. Rather, perhaps I should say, "ought to be," for it is not always easy to forecast the result when a deputation of the Local Authority has been engaged in the interesting occupation of inspecting and reporting on systems, which, for their adequate appreciation, would require the combined knowledge of the chemist, the biologist, and the engineer. The lessons to be drawn from sewage pollution of rivers in relation to sanitation by compulsion might be summarised by saying to those who are aggrieved—" Do not attempt to force an unreasonable pace," and to the offenders—" Do not need forcing to a reasonable one." Imitating the wisdom expressed in the old rhyme, which, while professing willingness to bless both the King and the Pretender, declined to specify which was which, I refrain from saying what I consider reasonable and what unreasonable.

I will have less scruple in dealing with the other branch which I mentioned—that relating to Building Regulations. Here we have the problem not complicated by abstract principles, but completely loaded with detail. I do not propose to deal with more than a few of these details, but from these few I may be able to illustrate the difficulties and perplexities which surround those who have to draw up and enforce such regulations.

It may be said that there are three parties interested in the framing and the carrying out of such regulations—the sanitarian, the builder, and the general public. The sanitarian has on the face of it no personal interest in the matter; his object is merely to secure the health of the community. He may make mistakes —in fact, as will appear, it is my opinion that he very often does make mistakes—but they are mistakes due to such innocent causes as striving a little too much after theoretical perfection. The builder has a direct personal interest antagonistic to the increase of cost, and very naturally looks with jealousy on any interference which he may regard as needlessly harassing. The third party, the public, is interested in seeing that its health is safeguarded, but is not anxious to pay the extra cost. One particular section of the public is in this connection of extreme importance; but the problem thereby presented is so large and serious that I would never think of touching it in the incidental way which alone would be possible now. I refer to that section which has a hard struggle to have any habitation at all, and whose difficulties may be increased even by the most careful sanitary regulations.

Building regulations and bye-laws have only recently become possible for landward districts. Previously, the counties were in the anomalous position that while they could insist on insanitary buildings being made sanitary, they could not prevent the construction of insanitary houses. This obviously was an ideal arrangement had its object been to produce the maximum of friction between the authorities, the builders, and the public. The new system, under which prevention has become possible, is an immense step in the right direction. Burghs have had similar powers for a longer time.

In drawing out such regulations, the object is to ensure that everything will be up to a certain standard, which to my mind ought to be the lowest consistent with safety, in the widest sense of that word. I do not consider that any public authority is entitled to demand more than this. There may, however, be great difference of opinion as to what really is that minimum. The problem of framing and carrying out regulations, which on the one hand will afford no loophole for the dishonest or perverse to creep through, and on the other hand will leave room for varying requirements and reasonable differences of opinion, such as may frequently occur even among men who are all thoroughly competent, is not an easy one.

To limit the subject, I propose to take up specially the question of the bye-laws for the carrying out of house drainage. Typical specimens of such bye-laws may be briefly exemplified as follows, the examples not being taken verbatim from any set of rules, but indicating merely the general drift:—

1. The house drain must be if possible outside the house, and of certain specified design and construction. If for any reason it has to be inside, then the stringency as regards these points is considerably increased.
2. All soil pipes and waste pipes must be outside—sometimes with a modification similar to the above.
3. No sink, basin, or bath is to be connected to a soil pipe.
4. All pipes must be tested to the satisfaction of the authorities.

There are of course many others, but these will serve as a sample. With regard to each of the above something may be said.

Other things being equal, a drain is better outside than inside the house, and it may be reasonable to hold that the further it is from the house the less need there is for care in its construction. The application of this to practical regulations, however, may land us in difficulties.

In April, 1886, I had the honour of reading a paper before this Society, entitled "The relative merits of cast iron and fireclay in house drainage." In that paper I strongly advocated the use of cast iron, and, although I do not suggest that I was alone, or nearly so, in holding these views, the prevalent opinion then was that the suggestion was a fairly advanced piece of faddism. I have the satisfaction of knowing that now, when a first class piece of work is desired, fireclay is for drains under the house a thing of the past. Even for drains near a house it is in a very doubtful position, and some building regulations put a considerable premium on the use of cast iron pipe. But it is less satisfactory to find, in some regulations of recent date, that no distinction is made between the two materials, but that when a drain for any reason has to pass under a house, an iron drain is put on the same footing as a fireclay one, although the one would stand as many pounds pressure as the other would stand ounces. The regulation to which I refer is that any drain under a house must be surrounded with concrete not less than six inches thick. As applied to an iron drain, such a regulation is not only grotesque, but is highly injurious, as it completely destroys its accessibility. In one bye-law I observed that the concrete was to be dispensed with in the case of *glass-enamelled* iron pipe. What the relation is between the concrete outside the pipe and the inside surface of the pipe I do not profess to know. What I do know is that such regulations naturally perpetuate the inferior style of drainage, by adding needlessly to the cost of the superior method. I have already said that other things being equal, a drain is better outside than inside. But other things are not always equal, and we often find a drain brought round a house by a circuitous route, thereby giving worse gradients and a much greater length of pipe, each yard of which is a potential danger. For my part, I would much rather live in a house which had an iron drain—glass-enamelled or not—through it, than in a house with a fireclay drain—buried in concrete or not—round it. I would much rather have a certain length of good drain through than even the same length of inferior drain round the house, and when to this is added that the inferior drain is much longer than the other, the preference would be correspondingly strengthened. Gases, as I have repeatedly found in testing, pass readily from leaks in an outside drain to the inside of the house.

In one set of regulations I have come across an awkward slip.

It is ordained that access openings must be provided, in itself a desirable thing, but these access openings are described by a proprietary trade name, by which the great majority of makes are excluded. This illustrates the need for excessive care in drawing up any compulsory provisions. Doubtless in this case the fact of the name being a proprietary one had escaped the notice of the framer of the regulations, but the result is none the less indefensible. Bye-laws specifying position and construction of drains require much more careful consideration than they have hitherto got.

The second provision to which I have referred, that all soil and waste pipes must be outside, has been for years a bone of contention between architects, whom I might call the more artistic class of sanitarians, and the more utilitarian, or at least less artistic classes. In many cases I confess that my sympathies are entirely with the architects. Perhaps in a new building it is reasonable to expect that the architect will either arrange the fittings so that his pipes may come down in some inconspicuous place, or design his elevations so that the pipes will not be an eye-sore. Perhaps he might even make them a feature. But in the case of an old building being remodelled, it is painful even to the ordinary eye, and must be doubly so to the artistic eye, to see the hideous monstrosities sometimes perpetrated in the name of sanitation. Another aspect was suggested to me recently. In small tenement houses it may be impossible to give each house a closet to the back, and rather than disfigure the front with a projecting soil-pipe the builder is tempted to resort to the expedient of a "common" closet, an arrangement, to my mind, much more objectionable than an inside soil-pipe.

The third provision, that no sink, bath, or basin should join a soil-pipe is another example of an excellent general rule, run to something like an extreme. I think I can trace its origin to the days when fixed basins in bedrooms were the rule in all houses with any pretence to luxury, and when at the same time sanitary construction was at a very low ebb. The early sanitary reformers found that many of these basins were connected direct to a soil-pipe, and that the connection was so bad that gases from the soil-pipe readily found their way into the bedroom. I have myself written many a report condemning this direct connection between a bedroom basin and a soil-pipe. In like manner a sink in a kitchen, which is virtually a living room, is so far open to a similar objection. But when in the same apartment we have a closet, a bath, and a basin, each protected by a trap of practically the same resisting power, I never have been able to see that there was any absolute sanitary necessity for putting up two pipes. On the other hand, there is not only the financial objection, but the sanitary objection that two pipes, each of them more or less fouled, are used in place of one, and further, that the water which might be used with advantage to flush one pipe is divided between two. I am aware of two arguments in favour of the two pipes. One is that in some classes of houses the bath might remain so long unused that the trap would dry up, and the other is that the action of the hot water might tend to produce leaks in the soil-pipe, if it were admitted to it. It may be questioned, however, whether it is desirable or even safe to put baths into a class of house where there is not a reasonable chance of their being used, and the other argument has lost much of its force in view of the much higher standard of construction which has been developed in the last few years. I am not advocating the abolition of waste pipes, but I believe that, as a compulsory requirement, the present enactments are too sweeping.

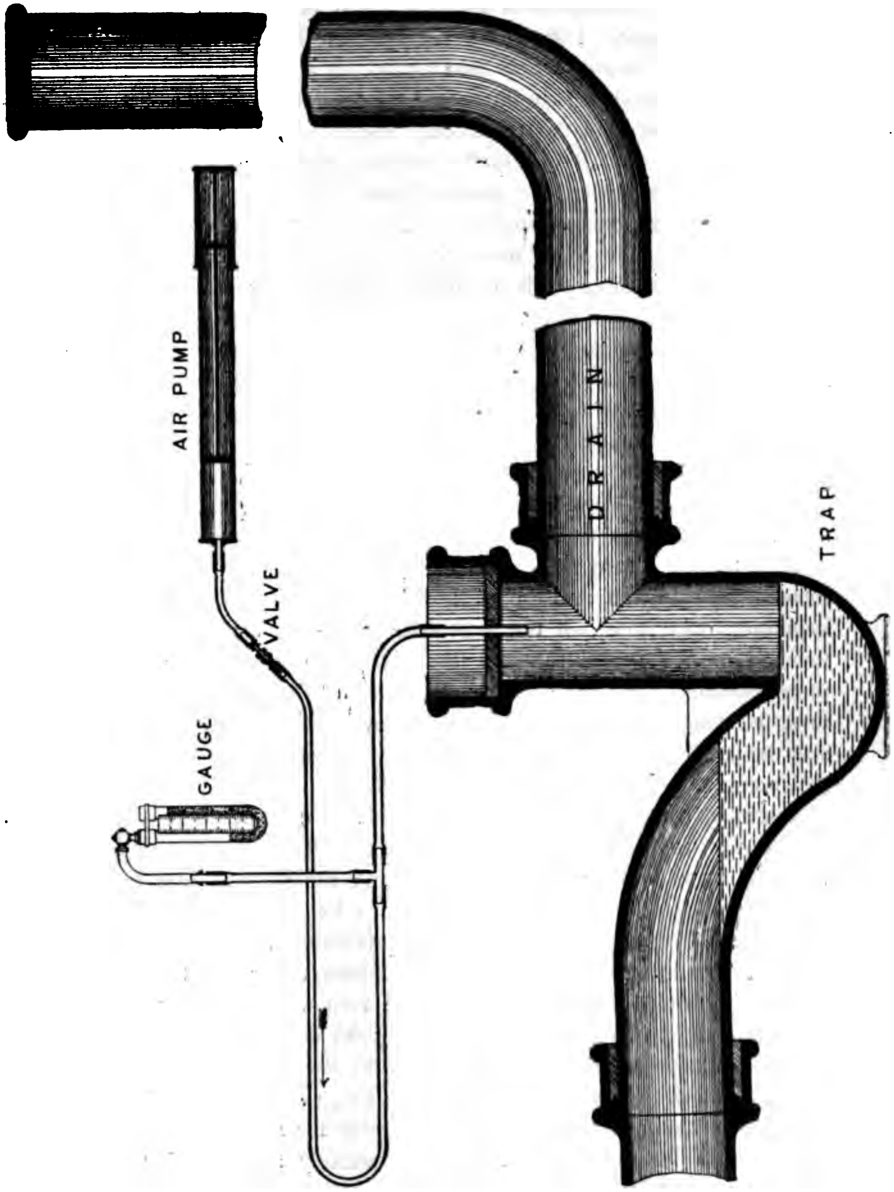
In these examples I have endeavoured to show that it is possible, by stringent and unbending application of rules which from a general point of view seem to be very desirable, to produce results which are not in accordance with what is desired and expected. The remaining provision, that which specifies the testing of drainage systems, introduces a new element.

The provisions with regard to drains and soil pipes being outside, and waste pipes separate from soil pipes, suggest a sort of nervous timidity, which refuses to believe in the possibility of such appliances being made and kept perfectly air-tight. The provision for burying a presumably good pipe in concrete suggests a ludicrous and humiliating confession of its inefficiency. Fifteen or twenty years ago, unfortunately, such a state of mind was more than justified, but the science and art of construction have made some progress since then. Judging from drainage bye-laws, one would scarcely come to that conclusion. Not only have we such regulations as those to which I have referred, but the methods of testing are no more up to date.

If the regulations as to testing have any meaning at all, their object is to ensure that every system constructed in accordance with them will be air-tight. The provision usually is that the whole system is to be tested to the satisfaction of the Sanitary

Inspector, sometimes to be *smoke*-tested to the satisfaction of the Sanitary Inspector. All drains are to be left uncovered till this is done. How does this official set about the test? Almost invariably by filling the system with smoke under a slight pressure, and then by sniffing and searching along drains and soil-pipes, using nose and eyes to detect any escaping smoke. If none is found, the drain is passed; if any is found, something must be done to repair it. Does the failure to find any such escape prove the system to be air-tight? Speaking from the experience of literally thousands of such tests, I say without hesitation that it does not. In many cases it is strictly accurate to say that nothing was found wrong; I know of no case where it could be said that everything was proved to be air-tight. The result depends on the wind, the weather, the inside temperature, the outside temperature, the eyes of the inspector, the nose of the inspector, his general intelligence, his experience, and I know not how many more contingencies. To decide whether the drainage system of an existing house is sufficiently tight is one thing, and for this purpose the smoke test is the best thing we have got. To decide whether a system which we are constructing afresh, and which we aim at making air-tight, is so in reality; is a totally different thing, and for this purpose the smoke test is utterly inadequate.

In March, 1897, a paper was read to the Architectural section of this society by Dr. Neil Carmichael, to whose scientific researches sanitation owes much. It contained the following:—"If our pipes were made in their substance and in their joints as tight as they ought to be, then a pneumatic test—air pressure with a pressure gauge—would determine absolutely if a pipe were sound. If defects were found—that is to say, if it were found not air-tight—then the location of the defect might be sought by the smoke test." I was present at the reading of this paper, but I fear had been somewhat inattentive, for this part had entirely escaped my memory till I came across it in the Transactions a few days ago. Meantime, about the close of 1897, circumstances had led me to make some practical experiments exactly on the lines therein indicated. I embodied the result of these investigations in a paper which I read before the Royal Scottish Society of Arts last November, under the title, "A suggested standard for drain testing." In it, while referring to the work of various others, I overlooked Dr. Carmichael's important suggestion, an omission which I am glad now to have the opportunity to repair.


AIR PUMP
VALVE
GAUGE
DRAIN
TRAP

My suggested standard was practically the same as Dr. Carmichael's, namely, air-tightness under a given pressure, as tested by a pressure gauge. I had, however, by that time gone a step further, and put the suggestion into actual practice, embodied in the instrument which is here illustrated. I do not of course assert that this is the best instrument that could be devised for the purpose, but I do assert that it effects the purpose, and enables me to refute any allegation that the proposed standard is impracticable. A gasfitters'-gauge, or, in more scientific language, a manometer, a few drops of water or of mercury, a bicycle pump, a bicycle valve, and two or three yards of rubber tubing, with a little brass T piece, constitute the whole affair. As it stands, with water in the gauge I can test any drainage system with a pressure up to 4 in. of water. By using mercury, the pressure can be increased up to about 4½ feet of water. When it is applied to test a system which is sealed by means of water traps, of course the maximum pressure that can be applied is that which is just sufficient to force the weakest trap. Incidentally, therefore, it will be seen that the instrument measures, and measures accurately, the strength of the weakest trap. If any more air is forced in, it simply bubbles through the said trap, and the gauge will rise no higher. Before beginning operations, all the legitimate openings, air-pipes, unfinished branches, and the like, are carefully closed up. The pump is wrought until the desired pressure has been reached, or until the gauge will rise no further. Pumping is then stopped, and the gauge is watched. If there is any leak, of course the gauge gradually falls, and, as Dr. Carmichael suggested, the leak is sought by using a smoke machine. If it is considered necessary to test to a pressure greater than that of the weakest trap, then the traps may be tightly plugged, and the pressure got by using mercury, combined, if you like, with a longer glass.

So much I could have said without any practical trial. But it is nearly two years since I made this instrument, and since then I have used it on every opportunity. The results have more than confirmed my previous opinions, and a good deal of what I put even last year as probable, I now give as the result of experience. I have applied the test to every new drainage system which has been carried out under my supervision, and for a very considerable time I have for such a purpose entirely abandoned the smoke test. Again and again I have found that a system of pipes which had triumphantly withstood the smoke test was so far from air-tight that the gauge could not be got to rise at all. Again and again in such circumstances it has been found, when the smoke test has been applied with the knowledge that there was something wrong, and that therefore something had to be found, that some joint had not been properly staved, or something else had been overlooked. With the higher pressure given by mercury, the leak may often be located by the hissing sound of the escaping air. So far, I have not found a fireclay drain which could stand the test at all. It is, however, right to say that the number of fireclay drains on which I have tried it is small. Practically, I never use them when I am anxious that the result should be an air-tight drain, but I have tried drains which other people intended and fully expected to be air-tight.

I have heard two objections in principle taken to this method of testing—first, that it is not severe enough, and, second, that it is too severe. I have already shewn that it can be made as severe as is ever likely to be desirable. I have often had to be content with a test a good deal less than the four inches of water—when, for example, water traps were included—and still have been confident that the test was infinitely more reliable than any smoke test could have been. If any one wishes to test to a pressure exceeding four inches of *mercury*, which he can easily do by using a deeper glass, I hope he will invite me to see the operation, but that he will either look well to his temporary plugs, or choose a day when he and I have each plenty of time. As to the second objection, that it is unduly severe, I fully sympathise with those who consider even the present tests burdensome. But I am convinced that what I advocate would not add to but diminish the burden. It would add to the first cost, for iron drains, up to and including the main trap, would be essential. But the element of uncertainty, which, in my opinion, is the most harassing and irritating part of the present system, would be removed. A drain which had passed a test such as this would give a certainty for many years to come that nothing could be seriously wrong, and therefore the recurring complaints about drain smells, drain illnesses, and the like, would either never exist, or could be promptly shown to be groundless. Compare this with the present state of affairs. A drainage system is completed and tested with smoke, and passed. If for any reason it has to be tested again, even within the first year of occupancy, it is perfectly possible that some leakage may be discovered, and as impossible to say where the resulting upturn may end. No wonder that proprietors and factors are averse to having their drains tested. However careful they may have been at first, and however faithfully the original smoke test may have been applied, they can never await with confidence the result of the next test. The cost of even a minor turn-up after the premises have been occupied, to say nothing of possible claims for damages, would far more than pay the extra cost involved in the higher standard of testing. I believe that, therefore, from the financial point of view this higher standard is desirable. I do not, of course, suggest that existing drains should be tested by air-pressure and condemned if they fail to stand it. Theoretically, it would be very desirable that all should conform to the highest standard; practically, no one would dream of insisting on it. But in the case of new work we have a clean sheet, and we wish to have it filled satisfactorily.

I would therefore ask—

Whether is it better in the interest of public health to insist on a number of somewhat intricate details, and at the same time to accept a doubtful material, and to test in a way which can never be thoroughly effective, or to give the greatest latitude in design consistent with safety, to insist on the highest standard of material and construction, and to test rigidity? And, further—

Is it justifiable for a Local Authority to insist on testing all new drains, and thereby giving a sort of moral warranty, without being sure that the test is a certain one?

Two years' experience of this test have proved not only that it is thorough and conclusive, which I think requires no demonstration, but that it is in no way difficult to carry out, and is much more expeditious than smoke testing.

I have purposely said nothing about the effect which escapes of drain air may have upon health. I have nothing to do with the question as to whether a leak indicated by a slight escape of smoke from an otherwise sound drain would be injurious to health. That is a medical question which I am not competent to answer. But I do know that whenever such a leak is found it is treated as a danger, and imperative action is taken to have it stopped. Therefore, I infer that those who framed and those who administer the law consider that it is a danger, and I simply ask them to be consistent.

I have already referred to the different interests involved in drawing out and enforcing such regulations. While I have said much which is in the nature of criticism, it is only right to show the other side of the picture.

I have only picked out a very few from the large number of regulations which have been drawn up and put in force both by burghs and counties. As my object was to press for improvement, I naturally chose those in which I found the greatest room for improvement. I do not say that there are not faults, perhaps many faults, to which I have not alluded at all, but I would guard myself most carefully against being taken to mean that the general tendency is other than good. A most cursory glance at any sets of regulations shows that care, skill, and intelligence have been required, and used, in framing them. But a new development, such as this is in most places, cannot be expected to spring up into sudden perfection, and it is chiefly by free criticism that improvement is to be expected. Nor must it be supposed that the responsibility for any sins of omission or commission rests altogether with those who drew up the individual regulations or bye-laws. Few towns or districts are in the position of Glasgow, acting under special powers. The Police Act of 1892, and the Public Health Act of 1897, are in most cases the foundation on which everything must be built. These Acts are not usually regarded by sanitarians as being above criticism.

I need say little by way of conclusion. Nobody likes to be compelled even to do what would otherwise not be specially distasteful. As we must have compulsion, no reasonable man wants it to be more irksome than is necessary. But, if adopted at all, it should not stop short of what is required to give satisfactory results. If it does, it causes needless expenditure, it falls far short of its possibilities of doing good, and it gives a false sense of security.

II.—*The Theory of Taxation.*

BY

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A MAN born in Great Britain, when he comes to a certain age and is found or suspected to be in receipt of an income above £160 a year, gets, first, an official letter asking him, not in the politest terms, to send in a statement of what his income is, and thereafter, whether he sends in a statement or not, he gets a second letter, in still less polite terms, demanding payment of so many pounds sterling on penalty of £20 and treble duty.

You will mark that his consent is not asked. He is born to pay taxes as the sparks fly upward. The tax is not a *quid pro quo* for a vote, for he may not have a vote; minors, of course, and aliens have no vote. It is in vain to protest. He may be a Quaker and object to the army and navy; he may be an innocent soul who never needs the attention of the policeman, and he may be so poor and pitiable that no one would ever think of robbing or maltreating him; he may not want education, or believe in it for other people; he may have no relations, and object to support other people's poor relations; he may be a republican and disbelieve in a queen, or an anarchist and disbelieve in a House of Commons; he may deny the obligation to pay a national debt contracted a century ago. He has to pay. And he will not easily find a place where he pays no taxes, or a country where he will get as much for as little as Great Britain.

Suppose he asks, with pardonable heat, "Who made the contract of the British citizen? who asked the government to do these things, and gave them authority to distrain in penalty of non-payment?" He is told there never was a contract.

Of course the explanation is that the contract has grown up without any formal beginning. The whole body of the citizens have the power of breaking it, seeing that the taxing authorities are under the control of their representatives in Parliament. Instead of that, they seldom raise the question. They are like men who begin playing a game; they do not make the rules, they do not even subscribe to them, they only begin to play. In so doing they accept the conditions they find, modifying them perhaps as they find defects and get others to agree in reforming them. But if a man tries to play and breaks the rules, he is sent to Coventry, there to reflect on what an unwritten contract means.

The freedom we enjoy and the burden we bear are both the outcome of centuries of evolution. There are defects, no doubt, in both, but we accept the bad with the good; that is, we accept the services which government renders to us, and we pay the price which the government charges, secure in the comfortable knowledge that the laws exist for the people, and that if we are not pleased—well, they are our own laws, and we can mend them.

This is the surface account of the matter; that the relation between the individual and a government found to exist and enforced by a majority, is really an implicit contract, and the surface account is generally as deep as an Englishman cares to go. But it has a philosophical foundation. Aristotle long ago told us that man is by nature a political animal. It is not good for man to be alone, so he got a wife. It was not good for them to be alone, and so they got children. It was not good for the family to be alone, and so men began to work into each other's hands, finding that there are certain things which cannot be had either in solitude or in small groups. And so the State, which has its germ wherever men pursue a common aim and divide their labours to secure it, became explicit.

Of course, the ordinary man never realises that his independence is dependence. He does not see that he relies on his fellow men for his very bread and butter, till, perhaps, some day the city holiday falls on a Monday, and his wife tells him that all the shops are shut, that she has forgotten to look ahead, and that there is no dinner to-day. A few more successive holidays would drive home the lesson that the richest man left alone will starve, because he has cut himself off from being his own provider. A few days of universal strike, and the civilised inhabitants of the west end would be breaking into each other's houses, and clubbing the inmates, in mad fulfilment of the saying, "Skin for skin; all that a man hath will he give for his life."

And if it is easy to see that man depends on man even for his very physical existence, it is more evident still that he depends on him for all those other things that makes life worth living as human life. Among the fowls of the air and the beasts of the field there was not found an helpmeet for Adam. Thus the political philosopher comes to the conclusion that the State is not a collection of individuals, who have merged their individual rights in the State, so that the State has no right which the individuals had not. Rather it is that the individual has no rights except such as the State gives him; it is the State which gives him the very condition of being a man; it is the State which alone permits the individual to follow out the pursuits which are the end and the crown of human life.

Thus, externally, the State takes the form of organised force. In other times this force was so prominent that many mistook it for the essential thing—

> "Kings were by God appointed;
> And cursed were they who did resist, or touch the Lord's anointed."

But in our time it is not difficult to see that the power behind the throne is the General Will. The government is the force which we, of our own accord, put over us, or keep over us, to do our will and bidding.

We enforce that will against ourselves if we should forget ourselves, and, much more, against those of us who are enemies of the general will and desire to fight for their own hand. The government is a committee of ourselves, which we voluntarily set over us, to give us, first, the conditions of living, and, second, to give us the conditions of the good life. As Aristotle said, "The State comes into existence that men may live, and continues in existence that they may lead the good life."

The subject which I have to treat here is that part of the implicit contract which deals with taxation, and the first proposition which I have to put forward is, that the government renders us certain services which we pay for with part of our income.

Suppose that the defence and protection of the nation were a private business like any other; as, for instance, the great marine insurance companies, might fit out armed cruisers to accompany ships, or as our ancestors used to hire the free companies. Suppose that the post office and telegraphs were in the hands of a great limited company, as the telephone service is now, and as the tramway service is still in most cities. Suppose that all education were a private profession as it used to be.

Suppose again, that in the cities, each house had its own well, as is the case in so many coast places, or that the citizens bought their water from a cart, as they did in Glasgow at the beginning of the century; that we lit our houses with oil lamps; that each group of houses had its own private watchman, as we used to have in the suburbs. With a little imagination, aided by history, we can at least conceive of most of what we now call imperial and local government functions being undertaken by private enterprise.

Then the position would be that we were visibly buying these services, just as we buy the services of domestics; we should, that is, spend part of our income on them, and the price would appear among our ordinary expenses.

Well, the actual state of things is this. The division of labour means that great groups of men take up different services. A, let us say, is the agricultural class; B is the manufacturing; C the merchant; D the professional; E the domestic servant. A sells its products to B, C, D, and E; B sells its products to A, C, D, and E; C its products to A, B, D, and E, and so on. But, beyond these services which A, B, C, D, and E render to each other, and pay for by their own services—for industry, of course, is just a great co-operation of mutual service—they set aside another group of services to be rendered by F, and this they call government services. These services are so peculiar and so essential that we do not, as a rule, allow any competition in them. F is, as it were, our picked class, but the point I want to bring out is, that A, B, C, D, E, *and* F buy their services from each other, and pay for them with their own services. F is not a class outside; it is neither a special providence, nor a tyrannical power. nor the holder of any Fortunatus purse. The government servants buy their bread and butter from us, and we buy justice, defence, education, etc., from them. We spend so much of our income on food products; so much on manufactured goods; so much on commission to merchants; so much for doctors' bills, legal fees, sermons, music, etc.; so much on our cooks and housemaids; *and* so much on soldiers, sailors, judges, policemen, board school teachers, etc., etc. Let me now put this in a more concrete way.

There are two incomes which are not usually very clearly related to each other; the National income, by which I mean the sum of all our individual incomes, and the government income. The national income is some £1,500,000,000; the imperial income is £108,000,000; and the local government income—the income of county councils, parish councils, burghs, etc.— is say another £50,000,000.

The relation of the two is this—that the government income is contained in, and part of, the national income, and not an addition to it. The practical proof of this lies ready to our hand. Our national income, as I say, on the calculation of Sir Robert Giffen, is £1,500,000,000. What does this mean? It means that the total sum of goods and services produced and rendered by the various individuals of the nation is sold by them for a money price of £1,500,000,000. Now among this £1,500,000,000 appear the salaries, among others, of government, municipal, and other local servants, from the Lord Chief Justice with his £8,000 a year, to the blue-coated defenders of our peace with their 29s. 8d. per week.

It is not the case that we working folk make £1,500,000,000 of income among us, and then contribute about 2s. per £ of that to the government.

The truth is that we, all working together on our land and with our capital, make up a total sum of goods and services which adds up to £1,500,000,000 in money value. Among these goods are military, naval, and police services, civil services, justice and education, postal and telegraph services, service of the poor, provision of gas, and water, and markets, etc. And, just as we buy goods generally from each other, so we buy government goods from the government, and local authority goods from the local authorities.

I repeat, the £1,500,000,000 is the price of the whole of our real national income, and some £160,000,000 of it is the price which we pay for a particular portion of the real national income, called government services.

The obvious deduction from this is, that the ordinary conception of taxation, which looks on it as an evil, is a mischievous fallacy. Of course, it is an evil in the sense that we cannot get all these good things for nothing, just as it is an evil that we have to work for our living, and do not find it hanging on trees. But our ancestors did not regard it as an evil that they had to pay a halfpenny a stoup for their water—the evil was that they could not get enough water even by paying for it.

I imagine the source of the fallacy is, that many people think of taxation too exclusively as paying for the maintenance of armaments. Well, if you like to say that it is an evil to have to wear a sword or carry a pistol, I agree with you—in this sense that it would be much pleasanter not to have to think about defending one's life or property. And then it follows, that the taxation which pays for these protection services which allow us to dispense with carrying arms because, in the division of labour, the arms are carried by red-coated and blue-coated brigades, is an evil also. But, after all, there always have been thieves at home and robbers abroad. The evil is in having to reckon with them, not in being able to defend one's self against them; and the taxation for protection is no more an evil than the having to pay for food. And, of course, we have not yet forgotten the taxation of France before the revolution, when the privileged classes had managed to roll the entire taxation on to the peasants, and when that taxation was spent, not so much on national purposes, as on class extravagances, and for the ideals of glory and of national expansion, in which the peasant had no share. There taxation was an evil and a great one.

We are apt, indeed, to be misled by the historical incidents of taxation. The annals of every State are filled with the attempts of various classes to shift the taxes from one set of shoulders to another. Sometimes it was the landowners who managed to shift them on to the industrial classes, sometimes the other way about; and, all through, there is the attempt of both to put them on the broad backs of the working classes. When a burden is thus shiftable, the people who ultimately bear it get to think that the burden itself is an intolerable evil, not seeing that the evil lies in the fact that they alone have to bear it.

But in a democracy such as ours—which is really the nearest approach to a true republic the world has ever seen—taxation is a price for value received. It is the payment we make for services done to ourselves as individuals by ourselves as a government; it is an equivalent of benefit received; and, moreover, it is a payment regulated and determined by ourselves. He who cheats the tax-gatherer cheats himself, and would be rightly served if he were for the time outlawed, and shown that the penalty of not paying taxation falls on himself. Its best type and example perhaps is a government industry like the post office, or a municipal water supply, where the government evidently provides a commodity which we buy and pay for with a part of our income. In short, our national income is not £1,500,000,000 less income tax, but £1,500,000,000. Our individual income is not our wages less rates and taxes, any more than it is our wages less our butcher's bill; the tax, like the butcher's bill, is part of our annual expenditure. If the Corporation of Glasgow takes over the butchers' shops, and runs them as it does the tramways, our taxes will be greater and our tradesmen's books less, presumably, by the same amount. I repeat, then, my first proposition, that the government renders us certain services which we pay for with part of our income. This is the *rationale* of the principle that taxation should always be laid on income, not on capital.

Of course, this is a mere truism. And, of course, as in the case of most truisms, there are thousands of people who live in entire ignorance or entire disregard of it. If it is a truth so generally accepted that the man who proves it is wasting his time, how is that we hear so much grumbling about the increase of local rates? How is it that a candidate for a seat on any local board will always have a certain following if he promises to cut down taxation? Do we usually quarrel with paying for a thing if it is necessary and good? I am afraid we shall have to preach this truism a little longer before we get it into the popular mind, and impress the moral obligation of paying taxes on the popular conscience.

On the other hand, when I look at a common phenomenon of to-day, I am inclined to think that it is really a truism with great sections of the community. Undoubtedly, there is a call being made on the government and on municipalities to do more. The man who suggests a doubt whether management by a committee of councillors is an economic one, is looked askance at as having no proper pride in his city; and I can at least say for Glasgow that those who advocate the largest schemes of municipal enterprise are not rejected at the polls. Perhaps there is a reason for this. Take, for instance, that somewhat extensive proposal for old age pensions. One may have no earthly objection to the proposal. It is, one might presume, a poor man's scheme. If poor men, as a class, go to the government, and ask a provision for old age which will cost, say, ten millions per annum, they have every right to do so. But when the other question comes up of how this is to be paid, and we hear from every platform, "Let it be taken off rent, or profit, or anything you like except wages," one begins to ask questions. The last Trade Union Congress, for instance, suggested that the necessary funds should be provided by a graduated tax on all incomes above £300. There was no suggestion in this of some mysterious Fortunatus purse belonging to the State. Is it not possible that the present enthusiasm for the extension of government functions arises, not so much from the idea that some enterprises are best conducted by governments and municipalities, as from the idea that this rolls the burden of payment from those who benefit to those who are able to pay?

Now there is no use protesting against a tendency of human nature. We are all very willing to roll our burdens on to other people's shoulders. When the Chancellor announces that he needs more money, the answer of the comfortable classes, as a rule, is—"By all means; put some more on spirits or tobacco, but, what ever you do, don't put it on income tax." Indeed, we are all, as a rule, willing to bear a collective burden on the chance of shifting it. You may show a manufacturer that a general rise in prices will not benefit him or anybody else; he is always willing to risk it if he gets his own prices up. And I fancy that a good deal of the intermittent agitation for protection arises from the idea that the foreigner can be got to pay the bill in the shape of customs dues.

I am reminded of a little conversation I had with one of my colleagues while I was writing this paper. He was complaining bitterly that he could not get any money for apparatus from our governing body, the University Court. But, I objected, the Court has no money; its balance is dangerously near the wrong side as it is; if you get your apparatus you will find that all our salaries are curtailed. "Oh, yes," he replied, "but, you see, I'll only have to pay a fraction of that!"

But perhaps a more honourable excuse is to be found in want of knowledge. It is comparatively easy to show any intelligent man that a tax is a payment for service rendered to the community, and not a burden. But it is difficult for even a very intelligent man to understand why he should pay just 8d. per £ on his income. We buy bread and butter on an estimate that it is worth the money. We buy stamps and pay car fares on the same estimate. But we are not allowed even to ask the question if general government services are worth the money. We simply get a blue paper telling us, in truculent terms, that unless we pay our 8d. a £ by a certain date, we shall be fined a sum of £20. And the reason why everybody thinks that he pays too much, or, at any rate, that his neighbours should pay more, is that the most difficult question in the difficult subject of taxation is just this—Who should pay the taxes, and in what proportion should they pay them? It is this question that we have now to try to answer.

The first thing to clear up is, that this is a much more limited enquiry than at first sight appears. Government services are paid for in several ways, and on several principles. Taxation is only one of these ways, and its principle is quite peculiar. Let us take the larger question first.

I pay income tax at 8d. per £ of income. I pay poor rates at $4\frac{31}{32}$d. per £ of house rent. I pay gas at 2s. 2d. per 1,000 feet I pay 8s. 6d. for the upkeep of the path in front of my house. The payment of income tax is determined by the amount of my income. The payment of poor rates is determined by the amount of my house rent. I buy my gas as I buy my bread and butter. I pay for the path just what it costs to lay down two carts of engine ashes.

These payments, I think, may be roughly put into two groups. Where the service rendered by the government admits of being rendered direct to the individual or class, and that service is capable of being measured, the payment is according to benefit received or cost expended. But where the service is a general one, spread over the whole or a large body of the citizens, and not rendered direct to the individual or class as an individual or class, the price which the citizen pays is proportional to income or to rental. The former is the principle of government industries, like the posts and telegraphs, and of municipal industries, like tramways and gas, and it is the principle of fees and of special assessments. The latter is the principle of taxation properly so called, whether in the form of imperial taxes or local rates—imperial taxes being paid on income, local rates on rental.

The former group does not seem to need much explanation. We find its *rationale* in the payments we make to private purveyors for ordinary goods. Naturally so; for such government functions have been gradually taken from private provision. If a government or a municipality takes over a private industry, it is generally because it can do it better, or supposes it can do it better; we should not, I imagine, consent to it on any other terms. Now in every ordinary exchange, say, between a manufacturer and his customers, there are two sides—the seller considers what it costs him to produce; the buyer considers the benefit he gets. According as the buyer or the seller is the stronger economically, will the cost or the benefit predominate. So with government goods. They may be sold at cost, or above cost, or below cost; or they may have no reference to cost, as in the case of licenses and the like. But what the buyer, in all cases, thinks of is the benefit he gets; if he thinks he gets adequate benefit, he buys.

Of course, in such government goods, there is a certain element of compulsion, but so there is in all monopolies. If we use gas, we must pay the price the municipality charges, or go without. But if we buy thread, we must pay the price dictated by the Coats monopoly. All monopolies are limited by the possibility of substitutes; the government monopoly is limited, not only by this, but by the fact that it exists for the sake of the consumer. Thus we may say roughly that government charges of this sort are Prices, and that the justification and the measure of them is benefit received.

But the latter group does need a great deal of explanation. The only very obvious thing about it is that, while the benefit conferred on the citizens generally is undeniable, the great bulk of government services cannot be paid for on any measurement of benefit or cost.

The army and navy, for instance, form the great shield under the shelter of which we work secure from the interference of foreign enemies—for the world does not love Britain as she deserves to be loved—and this shield, of course, protects the Briton even when he works in foreign countries, and is subject generally to foreign jurisdictions and customs. So with the police—there are enemies at home as well as abroad; sometimes we are our own enemies, and Philip drunk appeals to Philip sober. But as this double shield covers us all: as it is the condition not only of our personal safety, but of that great divided and contractual industry on the quiet conduct of which we depend for a living, it is impossible to measure this benefit individually, and say—you are protected so much, and you are protected so much.

So with the school rate. We in Glasgow this year are paying

11d. per £ of rental for school board education. Some good people are indignant at this compulsory payment, for, say they, some of us have no children, and those of us who have do not send them to board schools. True. But the children being educated in board schools are the people on whom all of us have to depend in the future, to a large extent, for the provision of those things which make our life worth living. We all gain when the new generation grows up better educated than the last: it means that we have the factors of a larger national income, inasmuch as these children, when they grow up, are better producers, better workers, better servants. It was not pure philanthropy that made the millowners of last generation build schools for their half-timers; it had at least something to do with the calculation that these children would in due time become full-timers in the mill, and would be better workers because of the education. But, undoubtedly, it is not those who pay the heaviest rates that benefit most; it is the people who pay small rates, or no rates at all.

So also with the poor rate. It is the most altruistic of all taxes: it is even difficult to show how those who pay get any benefit from it. All that can be said is that it is the recognition of our common humanity; those who benefit are our poor relations.

In all these cases we recognise the common benefit, but we cannot measure the individual benefit to the taxpayer. We know the cost, indeed, but we cannot apportion it. The problem is very much the same as would be presented if Lord Kelvin discovered some way of improving the climate, and put the necessary appliances in the hands of the government. We should all be distinctly happier, and some of us *could* measure the benefit to ourselves by the extra rent we got for seaside houses, or for early green peas. But most of us would only be agreed in grumbling that we had to pay anything at all for a benefit which varied with our individual tastes and habits. So we cut the knot in a way that does, as I say, require a great deal of explanation. We charge according to income or to rental.

From old times this principle of payment has received a name. In rates and taxes, from the 14th century downwards, we find the payment for common benefits is allocated according to Ability or Substance—*juxta facultates.* Adam Smith only put old usage into a formula when he said that it was reasonable that expenses "which are paid out for the benefit of the whole society should be defrayed by the general contribution of the whole society," and put down as his first canon of taxation, "The subjects of every State ought to contribute towards the support of the government as nearly as possible in proportion to their respective abilities." It is certainly not, then, a modern idea; it is not the result of the democratic vote.

It may be granted, however, that the expression "ability to pay" is a little misleading. At first statement it seems as unjust to the rich as taxation is often assumed to be to the poor. If, when you went into a shop to buy eggs, the shopman would not render his account till he had ascertained how much your income was, and then charged you five shilling a dozen if you were rich, half-a-crown if you were well off, one shilling if you had £160 a year, and nothing at all if you were in receipt of a pound a week, your opinion of the propriety of this would vary according to the class to which you belonged, and, I daresay, the only one who would unqualifiedly approve of this would be the last. It seems to convey the idea that, because a man has a good deal in his pocket, it is an excellent reason why he should take a good deal out of his pocket. It reminds one of Robin Hood's code of morality—that he stole only from the rich.

If we replace the expression by Ability to Contribute, by Capacity, or by Faculty, we begin to see reason in the principle. Seligman says, "It is the duty of the citizen to support the government according to his capacity to support himself." The State is a great family. But the State is ourselves. We, therefore, contribute to the national housekeeping in the measure of our own housekeeping. We give it freely, because we give it to ourselves and for ourselves, not to an outside power which taxes us in proportion as our pockets are able to stand the drain. The expression "ability to pay," or "ability to contribute," is objectionable only so long as we conceive of the Government as an outside, and so far hostile, body, which takes advantage of us, instead of as ourselves assessing our own ability to keep the larger family in the best possible condition.

The conception, however, was put on a more satisfactory basis by Mill:—"Government," he said, "must be regarded as so pre-eminently a concern of all, that to determine who are most interested in it is of no real importance. If a person or class of persons receive so small a share of the benefit as to make it necessary to raise the question, there is something else than taxation which is amiss, and the thing to be done is to remedy the defect, instead of recognising it and making it a ground for demanding less taxes. As, in a case of voluntary subscription for a purpose in which all are interested, all are thought to have done their part fairly when each has contributed according to his means—that is, has made an equal sacrifice for the common object; in like manner should this be the manner of compulsory contributions; and it is superfluous to look for a more ingenious or recondite ground to rest the principle upon." *

Since Mill's time the accepted principle has been that, as regards common benefit, every taxpayer should be looked on as benefiting equally, and the payment accordingly should be an equal one; only the equality is to be measured, not in money, but in sacrifice. The government practically says—We do not ask of any man how much this service is worth to you; indeed we take it out of your hand to measure its worth; we say it is worth really an infinite sum; but we shall charge you a sum which corresponds roughly with the same marginal sacrifice of utility to you and to every taxpayer. It is not the truth that the rich are to be penalised because they are rich, or the poor to escape because they are poor. The economic conception is that the rich should pay much because it means little to them, and the poor should pay little because a little means a great deal to them. In short, the canon of general taxation is Equality of Sacrifice.

The answer to my question, then is that every man should pay taxes because every man benefits, and that every man should pay with a sum which represents an equal sacrifice to him.

It may be granted to the full that the word equality here takes us too far for the practical world. It is easy to demonstrate that there cannot be a common measure of happiness, and that, accordingly, there cannot be a common measure of sacrifice. Yet we do measure both the one and the other. Every time we spend a sixpence, we measure benefit and sacrifice against each other. Here is sixpence in my pocket. I am lord of all the shops in Buchanan Street to the extent of my sixpence. I spend the coin on one thing. In doing so I forego the enjoyment of all the other things purchasable in Buchanan Street. I calculate implicitly that the benefit I am likely to get from the sixpence-worth of goods I buy, outweighs the benefit I might get by spending the sixpence in any of the other ways.

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* "Principles," Book V., II., § 2.

But putting this argument on one side, it may be said that no very accurate measurement of sacrifice is required for our purpose. That purpose is to raise a very large sum of money with a minimum of burden to each. Now, we raise this sum from a very large number of people; and the hardship, or injustice, if you like to call it so, of a rough and ready measurement of equality is minimised by the smallness of the sum required from each.

I deprecate the argument commonly used, that the reason why there cannot be a common measure of sacrifice in taxation is that we are comparing two classes, one of which is in extreme poverty, the other in affluence. Certainly if you take a man on the verge of starvation and deprive him of one square meal, you inflict on him an amount of hardship which would outweigh almost any amount you can think of as deducted from the millionaire—unless indeed it were a million sterling. And, of course, if the community, as a whole, were on the verge of starvation, so that numbers were slipping over into the gulf through no fault of their own, we should not have our present problem, for it is scarcely conceivable that men would be allowed to remain rich. We should return to the ethics of the short-provisioned ship, or the besieged town, where all are put on an equal diet.

But without stopping to prove that we are not in this desperate position, and that the poorest class of persons willing to work, in normal circumstances, could spare something without being dipped over the marginal line of animal existence, let me say that the sacrifice demanded of the citizens, as payment for the services of the government, need not, with us at any rate, amount to a very serious privation. A man in receipt of even 20s. a week will, on due occasion—say a self-denial week of the Salvation Army—subscribe a coin of the value of a day's smoke. What would be the corresponding sacrifice among the richer classes? The day's smoke occupies a certain position in the standard of life of the poor man. Find what would represent the same place in the rich man's standard of comfort, and you have his tax, and this would probably be measured by a very large sum in money. For, observe, the day's smoke is perhaps the one luxury of the poor man's day. If so, the corresponding sum to be taken from the rich man would be all his luxuries for one day—a 365th part of the income he spent on luxuries. If we suppose that the poor man's one luxury—his smoke—costs him 2d., and that the rich man's expenditure on luxuries of all kinds is £1 a day, then the rate of taxation is that the rich man pays 120 times as much as the poor. In short, an equal sacrifice over the whole community, which takes a small sum out of the poor man's pocket, will take an enormous sum out of the rich man's, and yet both will pay equally as measured by sacrifice.

This is the first consideration I would advance in saying that a rough and ready comparison of sacrifice is sufficient for our purposes. If it is true that, behind any apportionment of expense, lies the great fact that taxation is payment for services, then it seems to follow that every man should assist in keeping up the framework of law and government, which is the condition of his life as a citizen. Poverty is no reason for entire exemption. It is easy to argue that certain classes are so poor that they should not pay anything, inasmuch as they have nothing but bare subsistence. This is just as logical as saying that some men are so poor that they should not pay for bread. For government being the condition of all decent life, it is a necessity as much as bread, and must be paid for by some persons. Only *to the extent that* people are so poor that the rest of us must let them have bread and pay their bills—that is, so far as they are paupers—is it expedient to let them escape paying taxes.

The second consideration is that the government does not try to assess the poor man's sacrifice. A person does not pay income tax unless his income amounts to £160 a year. I fear this has given rise to the idea that it is the duty—or, shall we say, the privilege?—of the rich to pay for the poor. This is certainly not the meaning of it. One reason belongs to the practice of taxation. namely that the expense of collecting the tax over a very large number of small incomes would run away with too much of the tax collected, and so violate Adam Smith's fourth maxim, that a tax should take out of the pockets of the people as little as possible over and above what it brings into the public treasury. But the real reason is that the poor man pays his taxes in another way, and yet in a way that lets the government escape the responsibility of assessing what his equal sacrifice is;—by letting him tax himself.

This brings me to notice a way of paying for government services which I have not yet mentioned. The National Budget showed last year a revenue of £21,000,000 from customs, and £29,000,000 from excise. The meaning of this is that we put heavy duties on tobacco, liquors, and tea, and that every time a man buys these he pays so much to the government. Now whatever be the artificial appetite born of custom, it is evident that these are luxuries necessary to no man's healthy life. If a poor man requires all his income to live on, he will not pay this taxation, for presumably, he will not buy luxuries. But if he does buy luxuries, it shows that he has a margin over necessaries. Though we are the richest nation in the world, we have not committed ourselves to the statement that the Briton requires £160 a year merely to live on. A wage much under this will buy a good deal of luxury, and why should the wage-earner not pay taxation? The only reason adduced why the poor should escape is that they cannot afford to pay for anything but necessaries, and this gives no ground for the proposition that the rich should pay for the poor man's tea, or whisky, or tobacco. And, of course, there is a very good reason why they should not. If one class pays all the taxation, and another class, much more numerous, receives its full share of the benefit, there is every inducement on this large class to insist on the government doing more and more. If a large majority gets to voting supplies, while the minority have to pay without benefiting, there is a distinct schism in the conception of government. It is one thing for a majority to dictate the services and the payments: it is another to allocate the services to one class and the payment to another.

There, then, are two strong arguments showing, I think, that the principle of putting an equal burden of sacrifice on all is not so difficult as it appears—first that in any case the sacrifice is not a very great one; and, second, that instead of trying to assess the poor at an equal sacrifice with the rich, we assess the rich, but leave the poor to assess themselves.

The point at which we have arrived is this. All payments to government must be justified on the ground of service rendered by the government; from the economic point of view, they are Prices. In the case of general services paid by Taxation proper, the price is a sacrifice price, and must be justified on the principle of equality of sacrifice. In the case of all other government services, the price must be not only justified but measured, however roughly, by benefit received.

But, having laid down these broad lines, I go on to say that the spheres to which these principles respectively apply are not at all clearly marked. There seems a tendency in many cases to widen the sphere where equal sacrifice rules, and to narrow that of benefit, while, in one great department, the principle of benefit seems to be pushing out the principle of equal sacrifice.

(I). The peculiar circumstances of cities, or perhaps the strength of the working-man vote, seem to throw more burden on the comfortable classes. There is, for instance, in Glasgow an agitation, which has considerable support, for free ferries across the Clyde, the *rationale* of it being that ferries are really bridges. At present thousands of working men cross the river several times a day, and pay a halfpenny per journey: they pay for ferries as they pay for gas. But, if the ferries are made free, the working men who use the ferries will pay almost nothing, and I and other working men who never cross the ferry, will pay, perhaps, a penny per £ on our rental. Again, with a Socialist majority on the Town Council, it is quite conceivable that, instead of running at a halfpenny a stage, the cars might be made free, and the expense charged on the ratepayer according to his rental. If this seems too ridiculous—the idea has already been ventilated—I may remind you that the government might have built schools all over the country, and yet charged fees to cover the expense. Instead of this, I pay 11d. per £ for the free education of other people's children.

(II.) In local taxation the canon of benefit seems to have a recognised place. Broadly speaking, imperial and local services are two branches of the one system, and are paid on the same general principles. We pay income tax, say, for army and navy; we pay police rates for our blue-coated brigade. We pay 6d. for a telegram; we pay a penny for a car. It is really one taxation, divided, for convenience sake, between two branches. But, in spite of this, it is the case that local rates, modelled after imperial taxes, admit considerations of benefit that are not thought of in imperial taxes. At all events, the question is at once asked about any increase of a local rate, or the imposition of a new rate, who benefits by it, and how is the benefit allocated?

The reason for this is to be found in those practical considerations from which taxation never escapes. If the sphere of our taxation were a City-State as in old Greece or mediæval Italy, or like, say, the little republic of San Marino, with its 11,000 inhabitants grouped on an area of 36 square kilometres, all taxation would have only one canon, that of ability to pay or equal sacrifice.

But when, for practical purposes of collection and administration, the taxation is divided into imperial and local, the *test* of ability is differentiated. In the one case it is income, in the other it is rental. Now, a man's rental may be in proportion to his income, but it may not. In times when local rates arose, there was perhaps a fair proportion between the two, Agriculture was the great industry, and the rental which a farmer paid for his house and land was a fair criterion of his income; indeed, we admit this in charging him to income tax even now on one-third of his rent. As for others the persons with high salaries were generally engaged in the service of the government, and difficult to deal with as inhabitants of a parish; and the majority belonged to that class which would not be assessed in any case, their ability being zero. But as industry grew more complex and wealth increased, it was necessary to find a "visible ability," and this visible ability was determined by rental.

Mr. Cannan has shown this most clearly in his admirable account of the evolution of the poor rate,* the argument of which I follow. The relief of the poor is a national service, which is as impossible of individual measurement as that of defence and administration. The poor rate accordingly should, in theory, be assessed on the same principle, namely, general ability, and the fact is that it was so assessed in its beginnings. At first poor relief took the form of alms. In Edward VI.'s time this almsgiving was organised. It was enacted in 1551-2 that a register or book should be made up containing the names of the inhabitants and householders, as also the names of all such impotent, aged, and needy persons as are not able to live of themselves nor with their own labour, and collectors appointed, which collectors, once a year, "when the people is at the church shall gently ask and demand of every man and woman what they, of their charity, will be contented to give weekly towards the relief of the poor, and the same to be written in the said register or book." If any one obstinately or frowardly refused to assist, he might be sent to the bishop, who would, "according to his discretion, take order for the reformation thereof." Naturally, this voluntary system did not yield the desired results, and in 1572 it was thrown over. The justices or magistrates were instructed "by their own good discretions to tax and assess all and every the inhabitants dwelling in every city, borough, town, village, or hamlet, to such weekly charge as they and every of them shall weekly contribute toward the relief of the poor people." The obstinate and froward person was to be brought before two justices of the peace, and, if he refused to pay his contribution, he was to be committed to the next jail, "there to remain until he be contented with their said order and do perform the same."

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* "The History of Local Rates in England."

Now, although the words are not used, there is no doubt that the canon of assessment here was the old one of ability or substance, which ruled local rates both statutory and non-statutory up till that time. As Mr. Cannan pointedly says, "the canon of alms-giving is ability." We are supposed even to-day to give as God hath prospered us, and the widow's mite is still counted equal to the gifts which rich men throw into the treasury. When the contribution was voluntary and unconstrained, as prescribed by the early Act of 1535, it is obvious that public opinion would regard it as fair that every man should contribute according to his real ability. The parson, in the exhortation ordered in the intermediate Act of 1547, would naturally tell his flock to give according to their means. The churchwardens in their gentle demands, and the bishop in taking order for the reformation of obstinacy under the Act of 1551-2, must, perforce, have been guided by the ability of the contributor. In assessing, taxing, and limiting upon the obstinate person who had refused to obey the bishop under the later Act of 1562-3, the justices could adopt no other criterion, and it is entirely contrary to all we know of the ordinary course of English legislation to suppose that, when in 1572 the justices were directed "by their own good discretions to tax and assess all and every the inhabitants," they were expected to follow a different principle of assessment from that which they were expected to follow in 1562-3, when they assessed, taxed, and limited upon the obstinate person "according to their good discretions." In modern phrase the poor rate was intended to be a local income tax upon the inhabitants of the parishes.

What, then, led to the change that the poor rate was levied on local property? It was just the impossibility of levying a local income tax. The history of the poor law shows a long struggle to adhere to the old canon. In some places stock-in-trade was taken as the test; in others, an attempt was made to get at salaries; but, as this closely affected the lawyers, there was a very good reason for it being unsuccessful.

In Scotland, Means and Substance was the test down till well into this century, and ceased to be so in Greenock only in 1880; but finally the visible test of property conquered. If a man is to be assessed for poor rates on his total ability, and if he lives in Glasgow, and has his shop in Paisley, there seems no way so appropriate to assess the total as to take his house in one place and his shop in the other as indicating his ability. "But," says Mr. Cannan, "it took almost two and a half centuries to make this transition complete."

Thus we get the explanation why this great tax, imperial in its nature, attached itself to rental instead of to income when locally administered. What followed? This, that as all local taxation arose out of the poor rate and followed its lines, local taxation generally became attached to rental. But whenever this is the case, a phenomenon appears which did not emerge in the case of the poor rate. A man is not made more able to pay by an increase in the relief of the poor; but his property does increase in value in consequence of improvements affected by local taxation, such as drainage. In short, benefit becomes measurable, and the eye of the tax-gatherer finds growing ability to pay in the increased value of property. And so it comes that, "in practice, the nearest possible approximation to local rating according to ability, and the nearest possible approximation to rating according to benefit, are one and the same thing, namely, the rating of persons in respect of fixed property in the district." *

It must be confessed that, in point of theory there is an anomaly here. The poor rate might be described as even more of an imperial tax *in natura* than the payment for defence or justice, inasmuch as the service in question is not rendered to those who pay for it. It is in fact almost pure burden—the price we pay for our failures. The education rate cannot be called pure burden. It is a service rendered to the numerical majority, although, as benefiting the youth of the working-classes, the nation, in the next generation, will have better workers. But it is paid principally by the section of society which gets least direct advantage from it. The police rate again is partly national, partly local, in its nature. We gain directly by the policing of Glasgow, but the nation gains in that Glasgow is not a centre of lawlessness. The national character of the service, indeed, is recognised by the upkeep of the prisons being charged on to the government.

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* Cannan, "History of Local Rates in England," p. 132.

Well, these rates, to the extent that they represent national services, should be assessed on the imperial principle: should be levied on income. From practical exigencies they are imposed on rental, and rental is at best an inadequate representative of ability to pay. A municipal income-tax, or a municipal death duty, would, in point of theory, meet this, but the former seems impossible, and the latter has scarcely been discussed.

The above are generally called the unremunerative rates. But, outside these, the rates which are paid by the inhabitants of towns approximate to the first group of government services I spoke of, where the service is rendered direct and is measurable. Therefore, in the case of the remunerative rates, we have the emergence of the phenomenon that, while, for instance, a high poor rate tends to depress the value of property, much of local expenditure actually raises the value of property. Thus it comes that we find ourselves admitting considerations of benefit;—judging of the propriety or impropriety of new rates, or increased rates, by the benefit conferred on the property, instead of by the ability to pay of the ratepayer.

Such, then, is the recognised theory of our taxation. It is easy to see that practical exigencies make it difficult, if not impossible, to follow exactly the lines of the theory. But, granting this I have no hesitation in saying that our taxation is redeemed from the charge of having no theory or principle.

There is another theory of taxation. It is that the government should find its revenue in a separate estate owned by the government. This was the theory of the Conqueror when he declared the land of England escheat to the crown, as the estate of a rebellious people. It was the theory of Mr. Henry George. Mr. George, you will remember, put before us two alternatives; to take the land or to take the rent of land. He advocated the latter as "a simpler, easier, and quieter way." With that theory I have nothing to do to-night. I shall say only four things:

(1) That, in order to get any adequate revenue, it would be necessary, as Mr. George saw, to take the rent from the present holders without compensation:

(2) That, as a "Single" Tax, it means, not an addition to our present taxes, but the abolition of them, and the raising of the revenue by the confiscation of one class of incomes:

(3) That the Taxation of Land Values, as a separate addition to our taxation, designed to get at income alleged to be escaping its equal share of burden along with other incomes, is an entirely different thing from the Single Tax:

(4) That, while the Taxation of Land Values, as an addition to our taxation, may be considered still an open question, no recognised economist has had a single good word to say for the Single Tax.

III.—*On Some Scots Words, Proverbs, and Beliefs bearing on Diseased Conditions.*

By Dr. RORIE, Cardenden.

[Read before the Society, 13th December, 1899.]

THE Englishman coming north for medical study is aware of the Scotsman's love of whisky, theology, sneeshin', and Robbie Burns, of his objection to instrumental music in churches, and of his inability to see a joke without the aid of the trephine. But the Scotsman's dialect he knows vaguely, except through the columns of *Punch;* and when an unwashed invalid asserts that his trouble is "a beelin' in the lisk," the student is doubtful whether to commence his examination at the cranium or the cremaster. And even the educated Scot, town-bred, and with the faint metallic taste of the congenital silver spoon still clinging to his palate, may fail to readily recognise the symptoms of his poorer compatriot when given in the homely vernacular.

For some years I have collected words that are in common use in Scotland in describing diseased conditions, and these, along with a few superstitions and *auld wives fraits* I have set down in this paper. The list, of course, can in no way pretend to completeness; some are not peculiar to Scotland; the spelling is more or less phonetic; while the meaning of several words may vary in different districts. With the dialect of Aberdeen, Kincardine, Forfar, Fife, and the Lothians, I can claim a fair amount of familiarity, and it is while resident at different times in these counties, more particularly the great "kingdom," that I have compiled my list.

To commence with some anatomical terms, we find that a skeleton is ***an atomy***, an emaciated person being described as "reduced to a fair atomy." The cranium is the ***harn-pan,*** the brain *the harns.* The *openin' o' the heid* is in the infant the anterior fontanelle, but in the adult it is used loosely for the top of the head, the crown. The *haffits* are the temples; the *chafts*, the jaws; the *chowks*, the cheeks. The eye-lids are the *winkers*; the pupil of the eye, the *sicht o' the ee*, e.g., a foreign body in the eye may be described by the sufferer as being "fair on the sicht o' the ee." The *neb* is the nose; a person with a keen sense of smell being termed *neb-wise* or *nose-wise.* The *mou* or *gab* is the mouth, a prognathous individual being *gash-gabbit.* The *lug* is the ear; *hawse* or hass, *craig*, and *thrapple* are used for throat. The *pap*, *clap*, or *clapper o' the hawse* is the uvula, and when the *pap o' the hawse is doon* (relaxed throat) considerable difficulty is often found in persuading the patient that it is "up" again. The *briest* is the thorax; the *slot o' the briest*, the line of the sternum. The *wame*, *kyle*, or *baggie* (in children) is the abdomen. the *puddens* are the intestines. The *birth* signifies the external female genitals, *fore-birth* for vulva, and *hind birth* for anus being sometimes differentiated, although the more common term for the anus is the *back-passage.* The axilla is the *oxter*; an *oxter-staff* or *hiltie* is a crutch. The elbow is the *elbuck*; the "funny-bone," the *dirly-bane.* The *shackle-bane* is the wrist; the *loof*, the palm of the hand; the *nieve*, the clenched fist. The little finger is the *curnie*, the *pinkie* or the *pearlie*, while the terminal phalanges are the *nebs o' the fingers.* The nates are the *doup*, *hurdies*, *back-side* or (in children) the *dock*—to *pay the dock* being to bestow chastisement in that suitable situation. The sacro-iliac synchondrosis is referred to as the *couplins o' the back.* The *hainch* is the haunch; the ischial tuberosities, the *hunker-banes.* The groin is the *lisk*; the thigh, the *thee.* The *lid o' the knee* is the patella; the *yield* or *bught o' the knee* is the popliteal space; the *bran o' the leg*, the calf, and *cuit*, the ankle.

A tendon is a *leader* or a *sinon*; varicose veins being mistakenly termed *luppen sinons*, i.e., "sprung sinews." Ganglion is also so described. The *fell* is the deep fascia, a deep-seated pain being talked of as "betwixt the fell and the flesh."

A child possessing the *mens sana in corpore sano* is said to be *wise and warld like*, the opposite being, of course a *nateral* (imbecile) or an *objeck* (deformed person). A *sharger*, a *wierdie* or a *reglan* is an undersized *sma-boukit*, dwarfish person, these terms being applied to the smallest pig of the litter.

Of slighter deviations from the normal, we have a *lamiter* (cripple); to ***hirple*** (limp); to ***gang cheeky on*** (walk in a lop-sided manner, as, for example in scoliosis); to ***gley*** or to ***skell*** (squint), the adjective being ***gleyed*** or ***skellie-ee'd;*** to ***mant*** (stammer—stammer in Scottish dialect means to stumble); to ***isk*** (hiccough); to ***gant*** (yawn), with the proverb "they never gantit but wantit." ***Silly*** is used for weakness, not of the mind, but of the body; ***stout*** means robust, and ***unstout*** weakly. To describe a stout, fat person the term ***wamey*** is often used. ***Cob-wamed*** is pot-bellied, and I have found it more especially applied to stout females in whose case, owing to this, the mortified and curious neighbour finds it difficult to make a visual diagnosis of the existence of pregnancy. ***Boolie-backit*** (round-shouldered); ***humphie backit*** (hump-backed); ***bow-houghed*** (out-kneed); and ***shauchly*** (walking trailing the feet) are all common. An albino is described as ***blin'-fair;*** a left-handed man is ***car-*** ***cur-*** or ***curry-handit*** (contemptuously a ***curry-wheich***). and also ***derry-*** or ***kippy-handit*** or ***doakie. Deafy*** means benumbed, partially or totally devoid of sensation. (A marble that does not "stot" well is a ***deafy.***) A ***pawly*** finger is a sore finger; a ***whittle*** is a whitlow, a ***rat,*** a wart. A ***plook*** is a pimple; a ***fleein-oot*** or an ***oot-strikkin*** is a rash, ***fern-tickles*** are freckles.

A ***scart*** is a scratch; a ***chack*** is a nip; an ***income,*** a ***gatherin',*** or a ***beelin'*** is an abscess. ***Crewels*** or ***waxen-kernels,*** enlarged glands, more especially in the neck; a ***naar*** is the cicatrix left after suppuration in such glands. A ***dottle*** or ***melt*** is any stringy, tenacious substance, as for example the debris of a boil or the membrane of diphtheria. Necrosed bone coming away from a wound, in small particles, is described as marled (*crumbled* bone.)

To ***bok*** is is to vomit, to belch.

> "The cairlis with clubbis cowd ūder quell
> Quhill blud at briestis out bokkit."
> —(*Chrystis Kirk of the Grene.*)

A ***dry bok*** is a retching, and to ***gar the heart rise*** is to sicken.

To ***buckle*** a finger is to put a dressing on it. A frequent description of an injury is that the part has been ***staved*** (jammed) or ***rackit*** (sprained). A ***scob*** is a splint; a ***batter,*** a plaster.

Pain is variously described as being (1) a ***beelin'*** (throbbing) pain; (2) a ***yawin'*** or ***yarkin'*** (gnawing) pain; (3) a ***stoondin',*** ***loupin'*** or ***goupin'*** (shooting) pain.

The ***prefervidum ingenium Scotorum*** is proved, to a certain extent by the numerous words we have to describe mental conditions.

Vogie means excited; ***dowf, feckless*** (spiritless); ***dowie*** (sad); ***carried*** (delirious); ***moithered*** (confused); ***dovey*** (thick-headed); ***doitit, donnert, dottled*** (stupid through age); ***skeery, camsteery, rampageous*** (highly excited).

The commencement of menstruation is described as ***comin' the length o' a woman, turnin' no-weel o' hersel'*** or ***seein' her ain.*** A woman who has missed a period will say that ***her ain has left her,*** and when this happens finally she is said to be ***past the change.*** As regards menstruation it is steadfastly believed by the vulgar that any thing such as jam or preserves made by a menstruating woman will not keep, but will to a certainty "go bad." Quite recently I was told, in all earnestness that a newly-killed pig had been rendered quite unfit for food through being handled by a woman "in her courses;" all curing processes being useless to check the rapid decomposition that followed. (*Vide* Mosaic Law.)

When a woman becomes pregnant she is said to be ***on the road, gettin' stout,*** or, less politely ***breedin'.*** A husband engaging a medical man for his wife's confinement may delicately refer to the lady as being ***in the wey o' weel daein'.*** There is a popular belief that when pregnancy commences the husband is frequently afflicted with toothache, or some other minor ailment, and that he is liable to this complaint until the birth of the child. (Compare this with the custom amongst some savage tribes of putting the husband to bed to undergo a luxurious pseudo-puerperium, while the mother has to fend for herself as best she may.) One woman lately assured me that her husband "aye bred alang wi' her," and that it was the persistence of toothache in her adult son which led her to the (correct) suspicion that he had broken the seventh commandment and made her a grandmother.

A confinement is referred to as ***a cryin', a cryin' match,*** or ***howdie-wark.*** The woman may also be referred to as ***in the hole*** or ***in the strae.*** Every cockney can tell you now-a-days that ***a howdie*** is a mid-wife: fewer people know that the slang Scots term for an accoucheur is ***a finger-smith.***

Pregnancy is frequently dated from ***taking a scunner*** (disgust) at certain articles of diet—tea, fish, etc. While the woman is pregnant she must take care not to sit with one leg crossed over the other, as she may thereby cause a cross-birth. If she is much bothered with heart-burn she may rest assured that her future offspring will have a good head of hair; while a dietary embracing too much oatmeal will cause trouble to those washing the child, as it produces a plentiful supply of *vernix caseosa.*

When the child appears in the world it may have a caul (*coolie* or *happie-hoo*) over its face. This is a sign of good luck and is still frequently preserved. I was shown one fifty years old the other day, by its owner, a peculiarly unfortunate woman. The nurse examines the child to see that it is *wise and warld-like*, and that there are no signs of it being an *objeck* or a *nateral.* She may object to wash the bairn's *loof*[*] (palm) as being unlucky, and doing away with its chance of acquiring wealth; she will certainly object on the same grounds to your weighing the new arrival.

There will naturally be much chargin should the child have *hare-shaw* (hare-lip) or *whummle-bore* (cleft palate); but a *bramble-mark* or *rasp* (nævus), unless on the face, is not objected to, as it is supposed to indicate future wealth. Such marks are held to increase in size and darken in colour as the fruits in question ripen and fade as their season goes by. The belief in maternal impressions is of course fixed and certain, and wonderful are the tales told of children born with a snap on the cheek (through that favourite piece of confectionery having been thrown at the mother), or with a mouse on the leg—the only wonder being that with the prevalent female objection to mice, any child should escape having a mouse maternally impressed somewhere.

The sex of the child is discussed by the howdie, *a laddie* is held to be *carried mair to the front*, a *lassie to the back.* It is also well-known as regards the male parent that "ony laddie can get a laddie; it needs a man to get a lassie," a saying that may afford a modicum of consolation to the many-daughtered.

The tongue is examined and if the child is *tongue-tackit* (tongue-tied) speedy surgical interference is requested. As the child grows the scalp may be afflicted with *lust* (seborshœa), or more serious trouble such as *nirls* (measles), *watery-* or *crystal-pox* (chicken-pox), or the *branks* or *buffets* (mumps) may come on. *Nateral-pox* (small-pox) is rare, as most children have been *inockilate* (vaccinated). But the most common trouble of all is *hives.* Hives, like the "Poltics" of Count Smorl-tork is a "word that surprises by himself" many things, and is a haven of diagnostic refuge to the harassed practitioner. It usually means green, slimy, diarrhœa, it may mean anything or nothing. I know of the following varieties: (a) *Infleein'-hives;* (b) *Oot-fleein'-hives;* (c) *Bool-hives;* (d) *Thriving-hives. Infleein'-hives* or the *hives gaun inwan* (going inwards), is a frequent cause of infantile convulsions, as is the quick healing up of a *scabbit* or *scawt heid* (eczema of scalp) or a *beelin' ear* (otorrhœa). The *kink hoast* (whooping-cough) is also common and may be variously treated by the patient being taken (a) down a coal-pit; (b) to a lime-kiln; (c) to a gas-work; (d) to breathe over freshly dug earth. The advice of a rider on a white horse is not altogether disdained even yet, while the Hibernian treatment of passing the child under the belly of an ass has found a few Scottish followers.

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[*] *Burns* "The gossip keekit in his loof."

When teething commences so does trouble for the child, parents, and doctor. "They that get their teeth abune, will never wear their marriage shoon," explains itself: while "sune teeth, sune mair," crystallises the belief that the infant who cuts his teeth quickly will speedily have a rival claimant to the cradle. The *ee-teeth* (canine) and *chaft-teeth* (bicuspids) give most trouble, and at this time the counter-prescribing chemist reaps his harvest with *penny-poothers.*

"*Auld wive's fraits,*" you may say! Yes, but the auld wife has her followers, often devoted ones; while the faggot and the stake have unfortunately ceased to trouble her. It is the auld wife who advises cow-dung poultices, who uses urine-soaked dressings for *rose* (erysipelas), who applies *moose-wabs* (cob-webs) as a hæmostatic, and who tells you it is useless to administer a vermifuge unless the moon be at its height. (The idea of the unwary parasite taking an intestinal stroll by moonlight only to be savagely attacked by the wicked anthelmintic is distinctly good.) It is the old wife too who tells you she *pits in banes,* and that her skill is a matter o' *heirs-kep* (heredity). Where her knowledge fails she invents freely. One old lady—and she was proud to say that "physicians were in vain,"—cured herself of *pains* (rheumatism) by swallowing a piece of *fiddle-roset,* a quite unauthorised extension of the methods of the Guild of St. Cecilia.

And yet the auld wife has her dangers in the popular eye too. To meet an auld wife with a white "mutch" on, spells evil to the old-fashioned miner when on his way to the pit. It means accident either to the workings or to himself.

A curious and wide-spread belief which holds in England as well as in Scotland, is that concerning the possession by some men of a "white liver." A man may be a widower twice without much suspicion falling on him, but when it comes to "wearin'" a fourth or fifth wife he is set down as having a white liver, along with which pathological condition goes a bad breath fatal to the various wives. And thus the poor man ranks as a bilious Bluebeard.

Again, when a tooth is extracted it should not be carelessly thrown away, so saith the auld wife again. For whatever your age there is a chance of its being replaced if you burn it in the fire with a little salt, and repeat this incantation :—

Fire ! Fire ! Burn bane !
God gie me my teeth again !

or,

Burn, Burn, blue tooth,
Come again a new tooth !

A *werruck* is a bunion. "Ye've ower mony werrucks to get a man," is a common saying. Now to get a man is important, so note that

"Mim-moued maidens never get a man,
Muckle-moued maids get twa."

Rats (warts) can be treated in various ways. One cheap and always ready method is by the use of the "fasting spittle," the saliva before food has been taken in the morning. Well-licked the wart disappears. Dr. William Salmon, professor of Physic, in "The London Dispensatory" (1678), extends its use further. "Fasting spittle rubbed on often-times cures pimples, the stinging of serpents and the biting of mad dogs."

If you should be seized with a *grewsin* (shivering, rigor) care should be taken not to grip any part of the body; for where you grip, there suppuration is determined. If the breast is gripped, an abscess will form there, and so with the thigh, jaw, etc.; a popular confounding of cause and effect.

And when (to take another common belief) did "Skate-bree," i.e., the liquor in which skate has been boiled, first take rank as an aphrodisiac? Rustic badinage is to this day as broadly free and easy as when "The gyre-carlin" or "The wowin' o' Jenny and Jok," were fireside favourites; and the childless woman, too free with her tongue exposes herself to the repartee, a curiously muddled one, "Awa, and sup skate-bree!" The non-church going bucolic on whom Commissions of Assembly sit ponderously and ineffectually knows its reputation and believes in its efficacy.

While professionally engaged in watching the suckling of fools, I may also be accused of having not hesitated to chronicle small beer, in parts perhaps after the manner of the late François Rabelais.

But, however that may be I humbly throw my mite as a trifling addition to the treasures of philology.

IV.—*Biographical Sketch of the late E. C. C. Stanford, F.I.C., F.C.S., J.P., Past President of the Society of Chemical Industry.*

By G. G. HENDERSON, M.A., D.SC., Professor of Chemistry in the Glasgow and West of Scotland Technical College.

[Read before the Society, 10th January, 1900.]

EDWARD CHARLES CORTIS STANFORD, who was descended from an old Sussex family, was born at Worthing, on the 23rd of February, 1837. He received his general education at All Saints' College, Maidstone—where the late Rev. C. H. Spurgeon was one of his schoolfellows—and at Crawfurd College, Maidenhead. Even while yet a boy he showed great talent for chemistry, and gained prizes for that subject at both of the schools which he attended. Leaving Crawfurd College in 1852, he spent the next five years as a pupil of his father's, who was one of the founders of the Pharmaceutical Society, in acquiring a thorough knowledge of the various departments of practical pharmacy. During this period he also gained considerable experience in chemical analysis, and devoted much of his leisure to the study of photographic chemistry, which seems to have had a great attraction for him, and in which he gave the earliest indications of his powers as an investigator, his first scientific communication being a paper "On fixing by chloride of platinum"—a process which has since become of practical importance—published in the Journal of the Photographic Society, in November, 1856. In 1857 he entered the laboratory of the Pharmaceutical Society, then under the direction of the late Professor Redwood, and at the end of the year's work he distinguished himself by gaining two medals, one for Chemistry and Pharmacy, and the other for Botany and Materia Medica. In the same year he passed with credit both the Minor and Major examinations of the Pharmaceutical Society, of which he was admitted a member in 1860. After leaving

Professor Redwood's laboratory, he was occupied for one year in assisting Mr. T. B. Groves, of Weymouth, in his research work, and then for two years held the posts of Professor of Chemistry in Worthing College, and Lecturer on Chemistry and Physics in Crawfurd College. Towards the end of 1862, he was appointed Demonstrator in Chemistry and Pharmacy in the laboratory of the Pharmaceutical Society. Up to this time, Mr. Stanford's course of training had been of such a nature as to render him well qualified to follow in his father's footsteps as a pharmacist, but another path in life was shortly to be opened for him. He had already given proof of originality and skill in research by the publication of the results of several interesting investigations, and in 1863, he read to the Society of Arts a paper "On the economic applications of sea weed," which was of so striking a character as to gain for him the award of the Society's Silver Medal. In the same year he made a notable communication to the Pharmaceutical Society "On the manufacture of kelp," in which he described the new process which he had worked out, in which distillation in closed retorts was substituted for open calcination of sea weed. These papers attracted the attention of the Duke of Argyll, and the result was that Mr. Stanford came to Scotland in 1863, and proceeded to the island of Tyree, with the object of setting the kelp industry, then in its infancy there, upon a scientific foundation. Thus began his association with the Highlands and Western Islands, which lasted, without interruption, for a period of thirty-six years. The industry which he established developed rapidly, and large works were opened—notably at Middleton, Tyree, and Loch Eport, South Uist—while the improved methods of kelp production, which he had devised, were quickly introduced into Ireland and Norway. It deserves to be recorded that one result of Mr. Stanford's work as a pioneer was to provide lucrative employment, in the collection and burning of tangle, for many of the inhabitants of these remote and otherwise unproductive districts of the Western Islands. After eighteen months' residence in Tyree, he went to Clydebank, and, along with others, started the works at Whitecrook of the British Seaweed Company, of which he assumed the management. When the North British Chemical Company (now the British Chemical Company), was founded twenty-nine years ago, he became the managing director, and he retained this position until his death, on the 8th December, 1899.

Mr. Stanford's great ability, his love of research, and his power of turning his scientific training to practical account, enabled him to grapple successfully with the various problems involved in the extraction of iodine and other products from sea weed, and the numerous improvements in the manufacturing processes, which he originated, rendered the industry capable of surviving such blows as the introduction of iodine extracted from the iodate of sodium which occurs in the nitrate fields of South America, and the production of bromine and potash salts from the enormous natural deposits at Stassfurt. Naturally, some of his most important investigations were connected with the iodine industry, and one of these may fittingly be recalled on this occasion. In 1883, he communicated to the Chemical Section of the Philosophical Society a paper on "Algin, a new substance extracted from some of the commoner species of marine algæ," in which he gave a full account of the method of extraction, properties, and possible uses of that interesting body, which constitutes about twenty per cent. of the substance of sea weed. Few practical applications of Algin have hitherto been found, but recently Mr. Stanford succeeded in producing "Alginoid Iron," a compound which has been found of marked therapeutic value, as it is laxative instead of astringent in its effect when administered internally. During all his life he kept up his early connection with pharmaceutical chemistry, and one of his last pieces of work was the perfection of a method for extracting Thyroglandin, the active principle of the thyroid gland. He also had a keen interest in sanitary matters, and in particular he wrote largely upon the sewage problem, and, always practical, introduced the carbon closet system, which has been adopted in many large works. His inventive powers remained undiminished to the end, and less than a year ago, in his last scientific publication, he contributed to the Society of Chemical Industry a description of an apparatus for making infusions, provided with a most ingenious and easily regulated contrivance for automatically drawing off the liquid from the extracted body.

Mr. Stanford's energy and tact made him a valued member of many scientific societies, to all of which he rendered services of the first importance. He was elected a member of the Philosophical Society in 1864, and served for a term as Vice-President; he became President of the Chemical Section in 1873, and of the Sanitary and Social Economy Section in 1881. On the formation of the Scottish Section of the Society of Chemical Industry in

1884, he was unanimously chosen to be the first Chairman, and in 1893 he received the richly deserved honour of being elected to succeed a number of the most distinguished chemists in the country in the post of President of that great society. In 1892 he was President of the British Pharmaceutical Conference at Edinburgh, and he also served on the Councils of the Chemical Society and of the Institute of Chemistry. Many other honours fell to him in recognition of his scientific work, and of his services to chemical industry. He received the Silver Medal of the Society of Arts upon two occasions. The Graham Medal was awarded to him in 1884 by the Philosophical Society for his researches upon sea weed, and his discovery of Algin. On that occasion the late Mr. Coleman, then President of the Chemical Section, addressed the following words to the President of the Society, on intimating that the arbitrator had selected Mr. Stanford's paper for distinction from those submitted to him. "It is for this research that the medal is awarded, but we cannot forget that it is merely the culmination of the work of nearly a quarter of a century, by a chemist whose great ability has long been acknowledged by his fellow chemists, and whose patience and persistency is worthy of the highest admiration." He also obtained medals at many International Exhibitions in London, Dublin, Paris, Havre, and Vienna, for chemical products obtained from sea weed by his patented processes.

Incessant as was his scientific and technical work, yet Mr. Stanford's activity found vent in many other directions. A resident in Dumbartonshire for twenty-seven years, he identified himself with the affairs of the county, and was appointed a Justice of the Peace in 1887. As a politician, he was well-known in the capacity of President of the local Liberal Association; as a volunteer, he attained the rank of Captain in the 1st Dumbartonshire Rifle Volunteers; he was for some years Chairman of the School Board in Clydebank, and he was a Governor of the Glasgow and West of Scotland Technical College. He had pronounced views upon scientific and technological education, and he never tired of urging the claims of these branches to national or municipal endowment. A manufacturer himself, he insisted specially upon the necessity of the highest scientific training as a preparation for the pursuit of industrial chemistry, and gave earnest warning against the blind folly of trusting to rule-of-thumb methods. Thus, referring to the attitude still adopted by some manufacturers, he said, "... The manager, in his too exclusive wisdom, may be devoting his whole time to the saving of fuel and labour, little dreaming that some patient researcher in a far off laboratory may be quietly undermining his whole work." And again, "I think it could be easily proved that nothing pays better than original research, but it requires encouragement, for often the absolute necessity of living is against it, and a man may spend a life-time on an important subject, doing great work, of which only those who survive him know the value."

Mr. Stanford was a man of wide culture, with a mind richly stored with knowledge. He was an admirable speaker, and whether lucidly explaining some severely technical matter, or giving full play to his genial humour in lighter forms of address, he at once captivated the interest and attention of his hearers. He was a devoted husband and father, a staunch friend, and a wise counsellor, and his upright character, his amiable disposition, and his kindness of heart won for him the respect and affection of all who knew him. By his death, chemical science has suffered a heavy loss, the Philosophical Society has been deprived of a highly esteemed and distinguished member, and in many circles a blank has been left which it will be very difficult to fill.

The following is a list of his published papers:—

(1) "Fixing by Chloride of Platinum." *Photographic Society*, 1856.
(2) "Salt Efflorescences." *Chemical News*, 1860.
(3) "Researches on Atmospheric Ozone." *Chemical News*, 1860.
(4) "The concentration of alcohols in bladders." *Chemical News*, 1861.
(5) "Reinsch's test for Arsenic." *Pharmaceutical Journal*, 1861.
(6) "The economic applications of Sea Weed." Society of Arts, 1862.
(7) "The manufacture of Kelp." *Pharmaceutical Journal*, 1862.
(8) "A chemist's views of the sewage question." Philosophical Society (Chemical Section), 1869.
(9) "A chemical method of treating excreta of towns." *Chemical News*, 1869.
(10) "Chemical products from house-refuse and sewage." *Chemical News*, 1869.
(11) "Note on the action of house sewage on lead pipes." Philosophical Society (Chemical Section), 1869.
(12) "The Fulmar and Fulmar Oil." *Pharmaceutical Journal*, 1870.
(13) "Marbles from the Island of Tyree." British Association, 1870.

(14) "Note on a specimen of shell sand from the Island of Coll." Philosophical Society (Chemical Section), 1870.
(15) "The sewage question." *Chemical News*, 1871.
(16) "The Carbon Closet System." *Pharmaceutical Journal*, 1871.
(17) Address to the Glasgow Chemists and Druggists' Association. *Pharmaceutical Journal*, 1871.
(18) "A cheap disinfectant." *Pharmaceutical Journal*, 1872.
(19) Presidential Address to the Chemical Section. Philosophical Society, 1873.
(20) "The action of earth on organic nitrogen." Chemical Society, 1874.
(21) "The manufacture of Iodine." British Association, 1876.
(22) "On Algin, a new substance obtained from some of the commoner species of marine Algæ." Philosophical Society (Chemical Section), 1883.
(23) "Iodine in Cod Liver Oil." *Pharmaceutical Journal*, 1883.
(24) Chairman's Inaugural Address. Scottish Section, Society of Chemical Industry, 1884.
(25) "On Algin." Scottish Section, Society of Chemical Industry, 1884.
(26) "Alginic Acid and its Compounds." Scottish Section, Society of Chemical Industry, 1886.
(27) Presidential Address. British Pharmaceutical Conference, 1892.
(28) Presidential Address. Society of Chemical Industry, 1893.
(29) "Alginoid Iron and other Alginoids. *Pharmaceutical Journal*, 1898.
(30) "Thyroglandin." *Pharmaceutical Journal*, 1898.
(31) "An automatic apparatus for making infusions." Scottish Section, Society of Chemical Industry, 1899.

Monograph upon the Iodine Industry in Thorpe's Dictionary of Applied Chemistry.

V.—*On the Electrical Deposition of Copper.*

BY

J. CAMPBELL DICKSON, Associate of Glasgow Technical College.

[Read before the Society, January 10, 1900.]

OF late years considerable attention has been devoted to the Electrolysis of Copper and Silver in the Physical Laboratory of the University of Glasgow, and a vast number of experiments have been conducted with reference to the application of electrolysis for purposes of standardisation of electrical instruments.

In a paper, communicated to the *Philosophical Magazine* for November, 1886, by Mr. Thomas Gray, B.Sc., F.R.S.E., "On the Electrolysis of Silver and Copper, and the application of Electrolysis to the Standardisation of Electrical Current and Potential-meters," the author summarizes these University experiments, and discusses the relative merits or otherwise of Copper and Silver Electrolysis for standardising purposes.

On February 22, 1888, Mr. A. W. Meikle read a paper "On the Measurement of Electric Currents by the Electrolytic Deposition of Copper," before the Philosophical Society of Glasgow, dealing with a large number of experiments conducted by him on the above subject in Glasgow University Physical Laboratory. In all his experiments Mr. Meikle used solutions of commercial Sulphate of Copper with a specific gravity of about 1·17, and with 1% of Sulphuric Acid added. He used current densities varying from $\frac{1}{20}$ to $\frac{1}{500}$ of an ampere per sq. cm., or in other words his gain plates were from 20 to 500 sq. cms. per ampere. After describing his working arrangements and methods of manipulation, he went on to prove what great accuracy could be obtained by the employment of the electrolytic deposition of copper for purposes of standardisation of electrical current instruments. In this paper, however, as the result of a large number of experiments conducted by me in the Laboratory of the Electrical Engineering Department of the Glasgow and West of Scotland Technical College—at the suggestion, and under the supervision of Professor Magnus Maclean, M.A., D.Sc., F.R.S.E.—it is proposed to deal with the electrical deposition of copper in the ordinary form of Copper Voltameter, and to see what are *the effects of difference of density of the electrolyte* on the *amount* of copper deposited with different current densities. Whilst Mr. Meikle remarks that "it has been found that a variation in density from 1·1 to 1·2 makes no difference in the nature or quantity of the deposit." Mr. Gray says that "the effect of changing the density of the solution was only gone into sufficiently to show that no important error is likely to arise from this cause. The results of two experiments are given in Table II. They show a slightly smaller deposit from weak than from strong solutions; but the absolute difference of weight, only a fifth of a milligramme, if the somewhat doubtful result from the weakest solution be omitted, is too small to found any conclusion upon" (p. 404). Whilst the effects of difference of density has been my chief subject of investigation, it was found that the effects of corrosion could not be left out of consideration, and for purposes of comparison "pure" as well as acid solutions of copper sulphate were used in the experiments made.

Four solutions of copper sulphate were used, two acid and two "pure" as follows:—No. 1, of Commercial $CuSO_4$ with 0·5 per cent. of H_2SO_4 added, and having a high density of 1·185. No. 2 of Commercial $CuSO_4$ with 0·5 per cent. H_2SO_4 added, and low density of 1·119. No. 3, of Commercial "pure" $CuSO_4$ (free from iron) and high density of 1·175, with no acid added.

No. 4, same as No. 3, but with low density of 1·119.

Four current densities were used—

(1) One ampere per 30 sq. cm. of area on gain plate.
(2) " " 60 sq. cm. " "
(3) " " 100 sq. cm. " "
(4) " " 200 sq. cm. " "

The area is got by counting both sides of the gain plates.

In a number of preliminary experiments, current densities of 20, 50, 100 and 200 sq. cm. per one ampere were used, but the growth of the copper deposit on the plates of 20 sq. cm. was found to be so considerable in many cases, and entailing loss of particles of copper before the plates could be weighed, that areas of 30 and 60 sq. cm. were substituted for 20 and 50 sq. cm. in the subsequent experiments.

The instruments used in the experiments were—

(*a*) A Kelvin Rheostat.
(*b*) A Kelvin Centi-ampere Balance to measure the current.
(*c*) Four Copper Voltameter Cells.
(*d*) A Key.

The arrangement of instruments is shown by the diagrammatic sketch in Fig. 1. The four cells are seen to be in series, and between the balance and the negative terminal of the battery

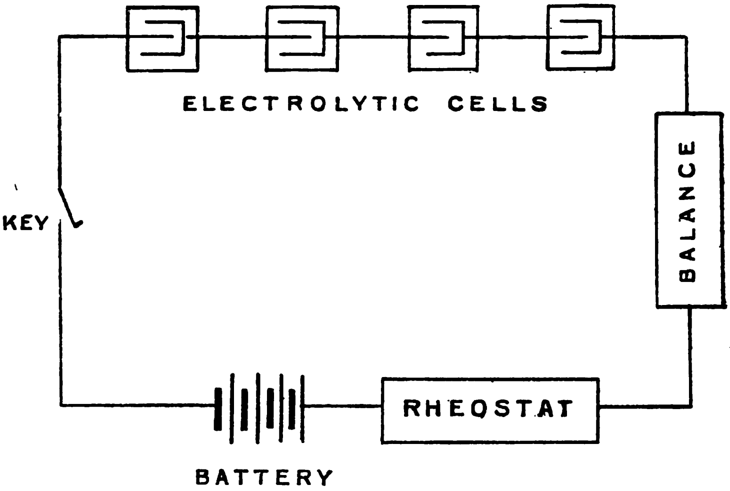


FIGURE I

This arrangement is necessary in order to make sure that the cells secure *all* the current in the circuit. With this view too, the wire connecting the balance and the first cell of the series is made as short as possible.

Current was supplied by a secondary battery giving a total difference of potential of 33·5 volts, the balance taking up 17 volts, the Rheostat about 12 volts, and the four cells about 4·5 volts. A current of 0·5 ampere was maintained throughout each experiment, and regulated by means of the Rheostat.

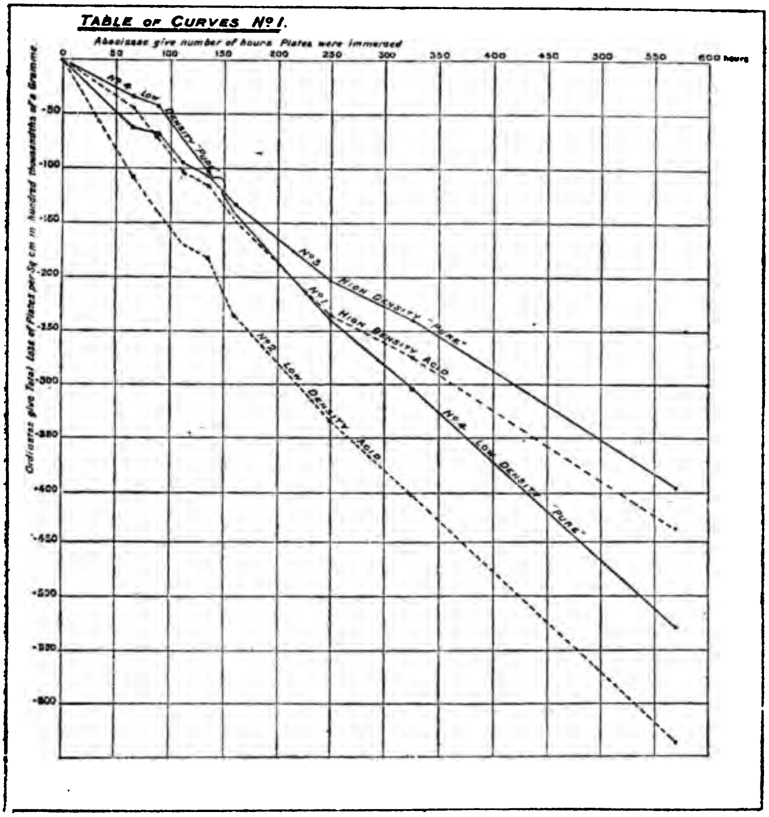
The depositions in every case lasted one hour exactly, the time being taken to one second of accuracy on a thoroughly reliable and accurate time-keeper.

Weighings were accurately taken to $\frac{1}{20000}$ of a gramme on a chemical balance with a 5·0 mg. rider.

In the electrolytic cells the plates were supported by a rectangular wooden frame, on one side of which was screwed a double clip, which held the two loss plates, and on the opposite side a single clip, from which was suspended the gain plate midway between the two anode or loss plates, so as to ensure an equal deposit of copper on each side of the gain plate. The three plates dip into the sulphate of copper solution contained in a glass jar which was filled nearly full with solution. The loss plates were made of high conductivity copper, $\frac{1}{8}$ inch thick. The gain plates were made of thin copper sheet, rectangular in form the corners being rounded off and the edges rubbed smooth with fine emery cloth. After cleaning the plates by immersion in dilute nitric acid, they were dipped into a solution of hydrate of potassium, and after well rinsing in water were dried, and were then ready to receive a deposit of copper. After being placed in position in the cells, the current was switched on for ten to fifteen minutes, so as to deposit a preliminary coating over the plates. While this was taking place, the Rheostat was adjusted till the required reading of 0·5 ampere was indicated on the balance; so that when the actual experiment which followed was made, little or no further adjustment of the current strength was needed. The circuit was then broken and the plates immediately removed one by one, beginning at the largest, and after dipping in water slightly accidulated with H_2SO_4 were washed by dipping several times in a large vessel of clean water. They were then *quickly dried* between pads of clean blotting paper, and if this was properly done —and no difficulty was experienced in doing so after a little practice—the plates assumed a clear pink colour. The plates were then gently swung before a warming stove to remove the last traces of moisture; and after regaining atmospheric temperature, they were weighed. The plates, being now ready for an experiment, were replaced in position in the electrolytic cells, and the current switched on by means of the key, the time at which this was done being accurately noted to one second. The balance was at once observed, and the current adjusted if necessary, and kept constant at 0·5 ampere during sixty minutes exactly, at the end of which time the circuit was broken. The plates were then at once removed and weighed, the treatment being the same as when they had the preliminary coating deposited on them.

The increase of each plate gives the weight of copper deposited; and as the deposit is produced by 0·5 ampere in 3,600 seconds—that is, by 1,800 coulombs of electricity—the increase of weight of each plate, divided by 1,800 gives the apparent electro-chemical equivalent of copper for that particular size of plate.

Before considering the results obtained as regards the nature and quantity of copper deposited, it will be advisable to look at the results of some experiments, conducted to investigate the loss of weight of the gain plates, caused by the corrosion of the different solutions of $CuSO_4$ used, and with no current passing. Four solutions of $CuSO_4$ were taken, corresponding approximately with the four solutions used in the deposition experiments. Four copper plates, each with an area of 30 sq. cms., were suspended for different periods in these four solutions. No. 1 plate was suspended in a high density acid solution, No. 2 plate in a low density acid solution, No. 3 plate in a high density "pure" solution, and No. 4 plate in a low density "pure" solution. The results obtained are tabulated in Tables I. and II.; and in Table of Curves I., curves are drawn shewing the total loss of the different plates after immersion in the four solutions, and also the rate of loss during successive intervals. The curves for loss in the acid solutions are drawn in dotted lines. Comparing the two high density solutions, it is seen that the loss after sixty-seven hours is *smaller* in the *acid* high density than in the "pure" high density, which seems to confirm Mr. Gray's statement that with saturated solutions "the effect of the addition of acid on the rate of corrosion was to diminish the loss." However, on comparing curves Nos. 1 and 3 (Table of Curves, No. I.) it will be seen that after about eighty-five hours the reverse is the case, the loss being *greater* in the acid than in the pure solution, and this remains so to the end of 570 hours when the experiment was ended. Comparing the two *low* density solutions, it is found that there is a greater loss in the acid than in the "pure" solution, this being the case throughout the whole experiment. This seems to prove that for low densities of about 1·120 the effect of adding acid is to increase the amount and rate of corrosion, and does not agree with Mr. Gray's statement that "the effect of adding acid to the solution seems . . . for densities between 1·15 and 1·10, rather to retard than to accelerate the action" (p. 401). Comparing the two acid solutions, it is seen that the loss throughout is greater in the low density solution than in the high density solution (Curves 1 and 3) the higher density appearing to have somewhat of a protective influence. Comparing the two "pure" solutions, it is seen that the loss is at first greater in the high density solution, but that afterwards the loss is smaller in the high density solution (Curves 3 and 4). It is interesting to note that after about 145 hours, and during the following 425 hours there is *greater* loss in both the acid and the "pure" *low* density solutions than in the two high density solutions; whilst for similar densities, there is *greater* loss in the *acid* than in the "pure" solutions.

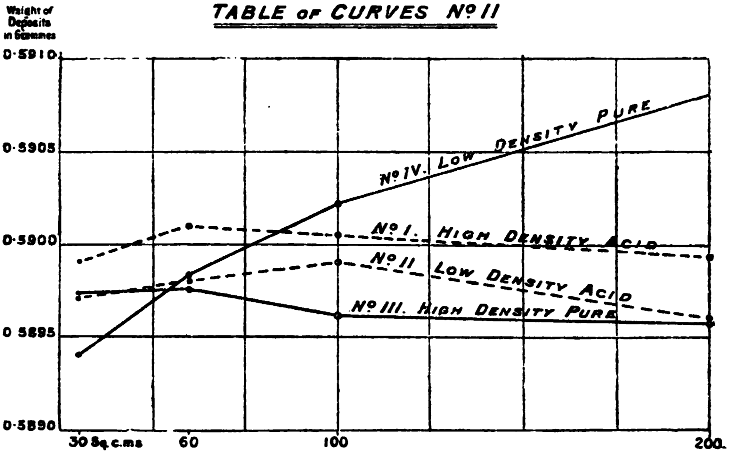


On referring to Table II. it will be seen that the rate of loss of weight of the copper plates in the four different $CuSO_4$ solutions was found to vary considerably during successive intervals. The rate of loss of weight in the high density acid solution was found to vary from 0·52 to 1·35 hundred thousandths of a gramme per sq. cm. per hour, in the low density acid from 0·51 to 2·12 in the high density "pure" solution from 0·29 to 1·16, and in the low density "pure" solution from 0·41 to 1·46 hundred thousandths of a gramme per sq. cm. per hour. The greatest rate of loss is seen in the low density acid, and the smallest rate of loss in the high density "pure" solution. It is also seen in Table II. that (with one exception the maximum rate of loss does not exceed $\frac{3}{200}$ of a milligramme. Mr. Gray states that, using solutions of densities varying from 1.05 to 1·20 with varying quantities of acid added, he found the rate of loss rarely to exceed $\frac{1}{200}$ of a milligramme per sq. cm. per hour. It may be remarked here that the plates suspended in the acid solutions after a short time assumed a darker colour, and a dull and somewhat pitted appearance, whilst the plates in the "pure" solutions remained comparatively bright and clean. At the end of the 570 hours it was found that the plate in the low density acid solution was darker and duller in appearance than the one in the high density acid solution; whilst the plate in the low density "pure" solution was tinged somewhat darker in colour than that in the high density "pure" solution, and both of them had a coating of reddish oxidation as if the bright plates had been exposed dry to the atmosphere—that which was in the low density solution looking as if it had been exposed to the atmosphere for a longer time than the other. Mr. Gray in his paper describes some experiments on "the behaviour of plates in solutions in which no acid was added. The first action is a corrosion of the plate, but after a sufficient time has elapsed the corrosion ceases and the plates rapidly gain weight by oxidation. This action goes on until the plates are nearly covered with brown oxide," the brown oxide subsequently forming hydrated oxide, and changing to a dark green colour, with further increase of weight. The brown oxidation in one case commenced after about twenty-five hours, and in another case after about sixty hours. This brown oxidation, combined with increase of weight as observed by Mr. Gray is mentioned, because in the experiments conducted by the author for a period of 570 hours, with the two "pure" solutions, no brown oxidation nor green deposit, nor increase of weight of plates was observed—in fact, the plates remained bright in the "pure" solutions far longer than they did in the acid solutions.

The results of the experiments on the electrical deposition of copper, with the four solutions mentioned at the beginning of this paper, will now be considered. These results are shewn in Table III., and Table of Curves, No. II. The ordinates give the weights of the various deposits in grammes, whilst the abscissae give the areas of the gain plates in sq. cms. per ampere.

Curve i. is the mean result of 5 experiments, using a solution of Commercial $CuSO_4$ of density 1·185, to which 0·5 per cent. by volume of H_2SO_4 has been added. The best deposit as regards quantity was obtained, using a current density of 60 sq. cms. per ampere. A current density of 100 sq. cms. per ampere gave an almost equally good result, the deposit being only $\frac{1}{10}$ of a

TABLE OF CURVES No II



Abscissae give Areas of Gain Plates in Sq c.ms per Ampere.

milligramme less in weight. The deposit appeared to be the best on the plate, having an area of 100 sq. cms. per ampere. In all cases the deposit was clean, tough, and adherent. The plate having an area of 30 sq. cms. per ampere could be safely used for two successive experiments without much growth at the edges appearing. At the end of the experiments the density of the solution had increased from 1·185 to 1·190, and a few crystals of $CuSO_4$ were found at the bottom of three of the cells. It may be here mentioned that, during the time occupied by each set of experiments, the loss plates were left suspended in the $CuSO_4$ solutions. This may partly account for the increase of density of the solution; but the increase may also be partly due to more copper going into solution from the loss plates during a deposition than is deposited on to the gain plates. Curve ii. represents the mean result of a set of 6 experiments with a 0·5 per cent. acid $CuSO_4$ solution having a density of 1·115. This solution was made up of the solution used in the first set of experiments, with the addition of enough water, containing 0·5 per cent. by volume of H_2SO_4, to dilute it down to a density of 1·115. It will be seen, on looking at this curve, that the heaviest deposit was obtained with a plate having an area of 100 sq. cms. per ampere. The deposit throughout was fine in grain, and tough, and adherent, but there was a greater tendency to "grow" about the edges and along the borders of the plates than was the case with the high density solution. This was particularly noticeable in the case of the smallest sized plate. At the end of this set of experiments the density of the solution was found to have increased from 1·115 to 1·119. Curve iii. is the mean result of 7 experiments with a solution of "pure" $CuSO_4$ of initial density 1·179. The heaviest deposit was obtained with a current density of 60 sq. cms. per ampere. The deposit with a current density of 30 sq. cms. per ampere being nearly as high, but this was most probably due to oxidation of the growth around the edges of the plate whilst drying, the growth being considerable with this high current density. The best deposit to look at was obtained with a current density of 60 sq. cms. per ampere. At the end of the set of experiments, crystals of $CuSO_4$ and small particles of metallic copper (evidently fallen down from off the loss plates) were found at the bottom of all the cells. The density was found to have diminished from 1·179 to 1·1725. This was due to a fall of temperature through 5°C., thus causing crystallization and a decrease of density.

Curve iv. represents the mean of nine experiments, made with the solution used for Curve iii. diluted down to a density of 1·115. At the end of the set of experiments this density was found to have increased to 1·1175. The curve is irregular and unreliable compared with the other three. The deposit was hard but brittle, and did not adhere well. With a current density of 30 sq. cms. per ampere, owing to the large amount of growth, the particles of copper did not stick well to the edges of the plates, the probable loss of particles before weighing thus accounting for the deposit at this current density being so low. The deposits with current densities of 100 and 200 sq. cms. per ampere appear to be abnormally high as compared with the rest of the results obtained.

Had the plates appeared to have been oxidised whilst in the solution, these high results might have been put down as caused by oxidation owing to a want of acid in the solution.

Mr. Meikle obtained a curve somewhat similar to this one, using a solution of density about 1·170 from which he said the acid had been withdrawn by shaking up with copper oxide. The increased weight of deposit in his case was evidently directly due to oxidation whilst in the solutions, as the plates were quite brown on being taken out. In my experiments, however, the plates were found to be free from visible oxidation—except in the case of the largest size of plate, and even then only a very slight indication was observed of any change of shade of colour from the usual clear pink colouration assumed by all the other plates. This very slight indication indeed of oxidation might partly have been due to oxidation whilst in the solution, but as the plate took much longer to free from moisture than any of the others, I am rather inclined to put down the oxidation as having taken place *after* removal from the solution and during the process of drying. This is supported by the fact that in the experiments on corrosion, the plate after being suspended in this solution, even after several days, shewed little or no visible oxidation. This, for one hour only, the time during which a deposition was made, would practically amount to nil. But seeing that in this solution, during the first 67 hours, the corrosion of the plate was less than in any of the other solutions, it is suggested that the high values obtained with current densities of 100 and 200 sq. cms. per ampere, might be owing to there being less corrosion than in the other solutions, combined with a little additional weight due to slight oxidation during the process of drying the plates.

Mr. Gray found that, unless the sulphate solution was "distinctly acid," the results obtained were too high, and says (p. 405), "The results with the nearly neutral copper sulphate were invariably too high, and this excess of weight was increased by having a copper plate in the solution. . . . The addition of a very small percentage of acid causes different solutions to give perfectly concordant results. One possible explanation of the peculiar action of the neutral solution suggested itself, namely, the formation of subsalts of copper when the solution was placed in contact with metallic copper, the subsalt giving twice as much copper as the ordinary sulphate. The real explanation is, however, I believe, the oxidation of the deposit while in the electrolytic cell."

My results, however, do not point so much to oxidation, and the suggestion of the possibility of "the formation of subsalts of copper" seems the more probable reason for the two results under consideration which I obtained, being somewhat too high. Whilst the freedom from oxidation seems to point to the "pure" low density solution being "distinctly acid," on the other hand, if it was "distinctly acid," the results should not have been abnormally high. As the "pure" high density solution had been used for a set of experiments, and had had the copper anode plates left in them for an aggregate period of seven days, before being diluted down for use in the set of low density experiments, any acid present should have been considerably used up, and the diluting with water would also have further reduced the percentage of acid in the solution. So that the probability is that the solution was not "distinctly acid," but that the irregular form of curve iv. is due rather to a want of acid. More consistent results were obtained with the high density "pure" solution, probably because it was freshly made up, and contained a little free acid at the commencement.

The general conclusions to be drawn from these curves are—

(1) The addition of 0·5 per cent. by volume of H_2SO_4 gives better and more reliable results, as shown by similarity of curves i. and ii., compared with curves iii. and iv., to which no acid was added. (Table of Curves ii.)

(2) With high density solutions, acid and "pure" solutions give similar curves, both showing the heaviest deposit with a current density of 60 sq. cms. per ampere, and gradually decreasing deposits as the current density decreases. The addition of 0·5 per cent. of H_2SO_4, however, gives better, heavier, and tougher deposits for all current densities, than when using a "pure" high density solution. (Curves i. and iii.)

(3) With both high and low density acid solutions the heaviest and best deposits are obtained with a high current density of from 60 (Curves i. and ii.) to 100 sq. cms. per ampere.

(4) "Pure" solutions of high density give more consistent and reliable deposits than "pure" solutions of low density; and the more free from acid, and the lower the density of the "pure" solutions, the less reliable are the deposits obtained. (Curves iii. and iv.).

The results obtained as regards the corrosion of plates in the various solutions will help to explain the relative positions of the curves—taking the results of the corrosion experiments after the first period of 67 hours. Curve ii. may be said to be below curve i, because a greater loss is proved to take place in the low density than in the high density acid solution. Curve iii. gives higher results than curve iv., because there is less corrosion in the low density than in the high density "pure" solution. Comparing the acid with the "pure" solutions of similar densities, curve i. may be said to be above curve iii., because the corrosion is greater in the high density acid than in the high density "pure" solution, whilst curve iv. is above curve ii. because the corrosion is greater in the low density acid than in the low density "pure" solution.

Thus, finally, this paper goes to prove that in the electrical deposition of copper from a solution of $CuSO_4$, the best deposits and the most reliable results are obtained by using a solution of $CuSO_4$ with a high density (of about 1·185), and to which about 0·5 per cent. of H_2SO_4 has been added, and with a current density of about 60 sq. cms. per ampere.

It may be remarked in conclusion that the value for the electrochemical equivalent of copper, under the conditions, and adding the loss due to corrosion in the sulphate solution, works out at 0·0003279 gms. as against Mr. Gray's value of 0·0003287 gms. for cathodes of 50 sq. cms. per ampere. This may possibly be due to a difference of standardisation of the current meters used in each case—Mr. Gray's experiments having been made some 13 years ago.

TABLE I.—Showing total loss of weight of copper plates, after immersion for different periods in solutions of copper sulphate of different densities, and with or without the addition of 0·5 per cent. of H_2SO_4.

Solution of Sulphate used.		Commercial Sulphate of Copper, with 0·5 per cent. H_2SO_4 added.				"Pure" Sulphate of Copper, no acid added.			
Number of Plate.		1		2		3		4	
Initial Density of Solution.		1·180		1·125		1·1725		1·115	
Final Density of Solution.									
Dates of Immersion of Plates.	Total time of Immersion in hours.	Total loss of weight in milligrammes, with area of 30 sq. cms.	Total loss per sq. cm. in hundred thousandths of a gramme.	Total loss of weight in milli-grammes with area of 30 sq. cms.	Total loss per sq. cm. in hundred thousandths of a gramme.	Total loss of weight in milli-grammes with area of 30 sq. cms.	Total loss per sq. cm. in hundred thousandths of a gramme.	Total loss of weight in milli-grammes with area 30 sq. cms.	Total loss per sq. cm. in hundred thousandths of a gramme.
Dec. 15, 1899.	67	13·40	44·5	32·50	108·3	18·67	62·2	10·05	33·5
„ 18, „	89	21·60	72·0	41·95	139·8	20·62	68·7	12·80	42·6
„ 20, „	112	30·95	103·2	51·15	170·5	28·67	95·5	22·20	74·0
„ 21, „	136	34·70	115·6	54·85	182·8	31·87	106·2	31·30	104·3
„ 22, „	161	44·50	148·3	70·80	236·0	40·02	133·4	42·30	141·0
„ 26, „	250	70·70	235·6	100·10	333·6	60·92	203·0	72·00	240·0
„ 29, „	327	82·40	274·6	120·60	402·0	72·22	240·7	91·35	304·5
Jan. 8, 1900.	570	130·30	434·3	191·70	639·4	118·92	396·4	159·05	530·2

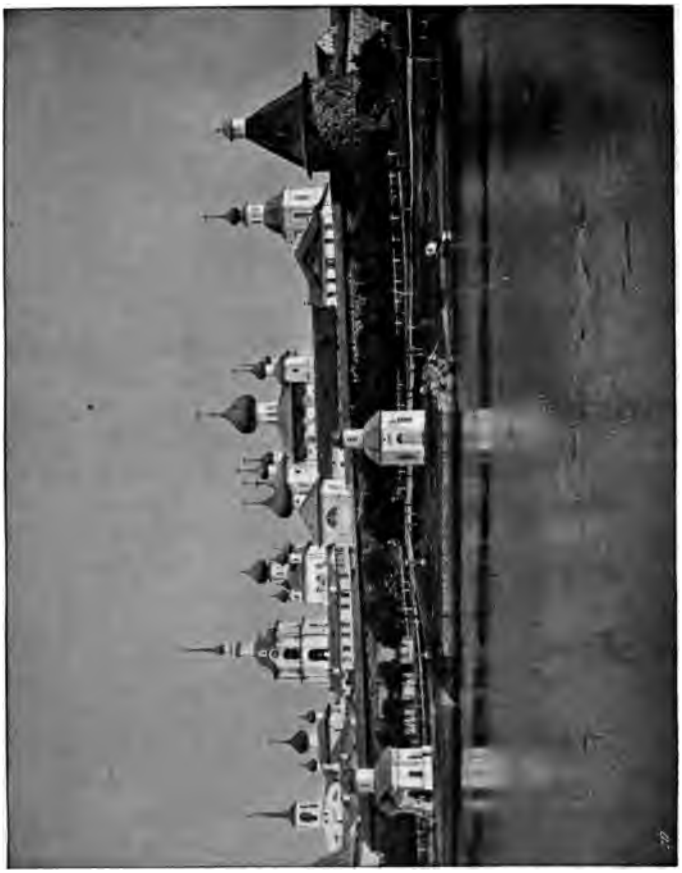
TABLE II.—Showing rate of loss of weight of copper plates, during successive intervals, suspended in solutions of sulphate of copper of different densities, and with and without the addition of 0·5 per cent. of H_2SO_4.

Number of Plate.		1		2		3		4	
Solution of Sulphate used.		Commercial with 0·5 per cent. H_2SO_4 added.		Commercial with 0·5 per cent. H_2SO_4 added.		"Pure" with no acid added.		"Pure" with no acid added.	
Initial Density of Solution.		1·180.		1 125.		1·1725.		1·115.	
Final Density of Solution.									
Dates of Immersion, 1899-1900.	Time of each Immersion in hours.	Loss in milli-grammes, with area of 30 sq. cms.	Rate of loss in hundred-thousandths of a gramme per sq. cm. per hour.	Loss in milli-grammes, with area of 30 sq. cms.	Rate of loss in hundred-thousandths of a gramme per sq. cm. per hour.	Loss in milli-grammes, with area of 30 sq. cms.	Rate of loss in hundred-thousandths of a gramme per sq. cm. per hour.	Loss in milli-grammes, with area of 30 sq. cm.	Rate of loss in hundred-thousandths of a gramme per sq. cm. per hour.
Dec. 15	67	13·40	0.66	32·50	1·61	18.67	0·93	10·05	0·50
" 18	22	8·20	1.21	9·45	1·43	1.95	0·29	2·75	0·41
" 20	23	9·35	1.35	9·20	1·33	8.05	1·16	9·40	1·36
" 21	24	3·75	0.52	3·70	0·51	3.20	0·44	9·10	1·26
" 22	25	9·80	1.30	15·95	2·12	8.15	1·08	11·00	1 46
" 26	89	26·20	0.98	29·30	1·09	20.90	0·78	29·70	1·11
" 29	71	11·70	0.55	20·50	0·96	11.30	0·53	19·35	0·90
Jan. 8	243	47·90	0.65	71·10	0·97	46.70	0·64	67·70	0·92

TABLE III.

Showing weights of deposits in grammes with different copper sulphate solutions and with different current densities.

Copper Sulphate Solution used.	Density of Solution.		Current Density in sq. cms. per ampere.				Number of Experiments Conducted.
	Initial.	At finish.	30	60	100	200	
No. 1 Acid, -	1·185	1·190	0·58990	0·59010	0·59005	0·58993	5
No. 2 Acid, -	1·115	1·119	0·58970	0·58980	0·58990	0·58960	6
No. 3 Pure, -	1·179	1·1725	0·58972	0·58975	0·58961	0·58958	7
No. 4 Pure, -	1·115	1·1175	0·58940	0·58982	0·59022	0·59081	9



SOLOVETSKI MONASTERY.

VI.—*A Pilgrimage to Solovetsk.*

BY

SAM. MAVOR, F.R.G.S.

[Read before the Society, 7th February, 1900.]

THE course followed in this journey was that rendered romantic by its association with the intrepid explorers who first found a north-east passage into Russia. Sir Hugh Willoughby and Richard Chancellor in their search for a northern passage to China, rounded the North Cape, and sailing eastward along the coast of Lapland, entered the White Sea. Willoughby who attempted to winter there, was frozen in, and with his seventy companions perished of cold. But the more fortunate Chancellor reached Archangel, and thence by way of the Northern Dwina, travelled to Moscow, and a century-and-a-half before Peter the Great opened at St. Petersburg his window into Europe, inaugurated commercial and political relations between the England of Queen Elizabeth, and the Muscovy of Ivan the Terrible.

In the absence of any direct line of steamers from this country to Archangel, the intending voyager may arrange for a passage on one of the ocean "tramps," which make summer voyages to the Northern Dwina, to load timber, or tar, or jute. But these vessels, giving the land a wide berth, keep far out to sea beyond the reefs and islands of the Norwegian coast. For a traveller who can afford the time, and who has not seen the coast of Norway, much the more interesting plan is to cross to Bergen or other port in South Norway, and thence proceed by Norwegian Coasting Steamers which navigate the intricate fiords calling at the many towns and settlements between Bergen and Hammerfest. By this route, he for whom the waves have terrors, may shirk the open sea, and incidentally include in his voyage, 1,200 miles of the grandest coast line in the world, the most rich in natural beauties and legendary association.

Owing to postponement of the date of sailing of a tramp steamer, an arrangement made with her captain to carry me to Archangel had to be abandoned, and the Norway coast route adopted. In June the excellent little Norwegian Mail Steamers are crowded on their northward voyages with young men homeward bound on holiday bent. The surplus sons of the hardy race of fishermen do not see scope for their ambition in a seat on the thwart of their father's boat, and they leave the trim settlements in their native fiords, to go afield to the Polytechnic schools and universities of Christiana, of Copenhagen, and of Germany, and then to win their way in a wider world. Every stopping place claims one or more of these sturdy youths, and the waiting boats manned by bright-eyed sisters (or others), beaming with eager welcome receive with much fond chatter the home made travelling trunk and its home-coming owner. The beautiful little crafts, the most graceful of their kind, and managed with a skill that tells of childhood spent upon the water—speed with their happy cargo to the shore, or their crews settle steadily to a long pull away up some dark fiord where their timber home sits at the meeting of the mountain and the sea. The settlements of these Nordland fisher folk are those of industrious and prosperous people. Probably none of them are rich, but none of them seem very poor, and they have evidently a tolerably high standard of comfort.

Between Tromso and Hammerfest are some of the most striking features of this disorderly and unshapely coast. Owing to the late summer, snow remained more generally than is usual. In every cleft and corry it lay to the water's edge, and on the higher mountains the eternal snowfields spread their wide expanse of glistening white, the view from seaward recalling the aspect of the north-west coast of Iceland. Glaciers wind between the mountains' flanks, and terminate abruptly where their huge snouts front the sea in deep green walls of solid ice. Here we were favoured with the most brilliant weather, and entered the region of the "Midnight Sun." On this wild coast the unearthly beauties of the colouring and the shades upon the mountains are grander far and more impressive than when the phenomenon is viewed on the open sea. No pen can paint the glories of these nightless arctic nights, the gold and purple splendours of the sky, the sea, and hills.

On leaving Throndiem, the steamer was overcrowded with homeward bound Norwegians, and I was the only foreigner; but as we progressed towards the Cape, our company diminished, until at Hammerfest only one other passenger remained—a fair-haired, beamy daughter of the North bound for Vadso, with a smile as bright and broad as an inverted rainbow.

Hammerfest—the northmost town in the world—was still surrounded by the winter snows, and here, while the summer sun shone through the night, the naked lamp-posts in the streets gave token of electric light. Guided by the route of the overhead cables, the visitor may find in a valley a mile or two away, a dynamo house where the power of a mountain torrent that plunges through a snow crested gorge is tethered to a turbine, and illumines the sunless days of winter in the little wooden town.

Near the North Cape the weather became dull and much colder with heavy rain, and the leaden gloom of sea and sky, and the mist wreaths on the snowy hills gave the grim arctic coast a weird and wintry aspect. The so-called North Cape, a bluff and lofty precipice, is not on the mainland, nor is it the northmost headland of Europe. This distinction belongs to the Nordkyn, which farther to the east and north thrusts out into the Polar Sea a promontory shaped like the ram of a battle ship. From Bergen to the North Cape the sailing had been almost entirely in the sheltered waters of the coast before a continuous and imposing panorama of jagged mountains, sombre fiords, and glaciers. The ever changing scenes and the ceaseless demands upon one's admiration had become fatiguing, and when the northern headlands were rounded, and the ship laid upon an eastward course encountering a bitter wind and tumbling sea, it was a relief to retreat to a comfortable cabin with the consciousness that nothing was being missed.

In the grey mist of a drizzling evening we groped our way through a fleet of quaint fishing craft of every size and shape, into the crowded harbour of Vardo, where through the rain-haze nothing was very distinct but the overpowering stench of putrid fish. The air was heavy with such a smell of every variety of fish in every stage of decay, as polite words are useless to describe.

Vardo, the principal town on the coast of Finmarken, is devoted entirely to the fishing industry, and the whole surface of the rocky little island is draped and festooned with the myriad carcases of codfish hung up to dry. Nothing could be more miserably depressing than the rain-sodden aspect of the mean little wooden town on this chill and cheerless evening. Timber houses when wet look wetter than stone buildings. The moisture clings to them and soaks, and the ceaseless drip, drip from the gutterless roofs into the puddles beneath, wearies the unaccustomed ear. About the slimy wharves of rotting piles, great open vats of crude cod liver oil add their sickening effluvia to the general stink. The muddy streets, the shore and wharves are littered with the decomposing inwards of the fish that hang around, and discontented looking goats feed on the trodden putrid garbage. No wonder they look dejected, these scavengers of Vardo; they have nothing else to eat. Even the cattle, but they are few, are fed on the boiled heads of codfish varied by a diet of seaweed. The only green is on the houses' grass-grown roofs, and this is nibbled by tame rabbits whose hutches are perched upon these scanty parks.

Last winter was severe at Vardo, and the town was buried under 20 feet of snow. The natives were now pining for the laggard summer, but although far within the so-called "Region of the Midnight Sun," they had scarcely seen his rays for three long weeks of chill incessant rain. Even the stoic fishermen were weary of the deadly monotony of the low sky whose uniform grey was only slightly less dull at mid-day than at midnight. It was not surprising that the Russians among them celebrated their national midsummer-day (their calendar the Julian is twelve days later than ours), in their customary way by drinking too much, and disturbing the peace with their wild shouts and drunken brawls.

Having arrived at Vardo, the immediate and most pressing problem was how to get away from the poor little waterlogged town and the all pervading poison of the atmosphere that broods around it. But the means of speedy escape were cut off, for the Russian Government had ordered all the steamers on the coast to carry free of cost to Ekaterina all who cared to go, for they wished to have some show of people at the official opening of Russia's first and only ice-free naval port. The traffic of the steamers eastward was thus completely disorganised, and the Russian agent at

Vardo was utterly in the dark as to when a vessel might be expected. There might be one to-morrow, or none for a week. It all depended on the Governor. There was nothing for it but resignation to the inevitable, and the first day was passed in visiting, under the guidance of the municipal engineer, the Hotel de Ville, which contains besides the council chamber and bank *the* public-house, managed by the municipality on the Gothenberg system. The other show places were the church, the new waterworks, and the schools. The last are large, and well equipped with appliances for teaching cookery, carpentry, dressmaking, etc.

While walking in the main street on the day following my arrival, a burly figure clad in reefing jacket emerged from the mist, and addressing me in excellent English, invited me to accompany him to his house. He proved to be the harbour-master, a former sea captain, who after many voyages had come at last to an anchorage in this little port within the Arctic circle. Vardo being an island, all strangers must enter through its harbour, and my new friend thus had an official interest in all new comers. His house like most sea-captains' homes was stored with strange—and here amid their chill surroundings doubly strange—souvenirs of distant lands. He and his wife had a lively interest in the Transvaal negotiations (July 1899), and, warm in sympathy with England, closely read the speeches of our Ministers, especially those of Chamberlain, whom they much admired. Keen politicians and sturdy democrates are these Norwegians, and persistent in their own home-rule agitation. But the matter uppermost in their minds was the fear of Russian aggression on their coast.

In former times the fort at Vardo dominated these seas, but now its only claim to distinction lies in its being the northmost fortress in the world. But its few old-fashioned guns, and score or so of soldiers, would be at the mercy of any modern gunboat. From a naval point of view the position has considerable strategic importance, and the recent activity of Russia on her northern coasts, and the growth of her naval power will certainly in the near future bring Vardo into unsought prominence as the key to the N. E. passage. The value to Russia of the acquisition of this safe and ice-free harbour as a naval base is obvious, and the Norwegians have a strong suspicion that their powerful neighbour is already casting covetous eyes upon the island. So definite is this distrust, that when on the day before my arrival the Grand Duke Vladimir (uncle of the Tzar) visited the harbour, this politest of people raised no flag in courtesy to the Prince, although princely visits to the little town are rare indeed.

With the help of the harbour-master I chartered a boat, and, shrouded in oilskins, crossed the strait to the mainland of Finnmarken to visit a whale station there. The intelligence and ferocity of the blue whale which abounds on these coasts rendered him so formidable and dangerous an antagonist that for many years he enjoyed almost complete immunity from attack. But now the tactics of the whaler are changed, and he assails his prey with modern scientific method, and the courage and strength of the gigantic brute must needs surrender to assault by engines and explosives. About ten small steamers are engaged in whaling from this station. Each at its prow is fitted with a gun which fires a long and heavy barbed harpoon headed with a large explosive shell. When the harpoon with stout rope attached is lodged deep in the victim's body, the terrible wound caused by the bursting shell is usually immediately fatal, but, if not, the whale may tow the steamboat until he succumbs to exhaustion and loss of blood.

The little vessels cruise about at a distance of twenty to sixty miles to seaward, and immediately a whale is captured the catch is towed straight to the whale factory. It was my fortune or misfortune to arrive during the cutting up of a 75 foot whale, and the scene of colossal sloppiness, messiness, and smelliness beggars description. Surely it was the very acme of stinks that pervaded this greasy factory of rancid blubber-soaked timber and offended the olfactory organs almost beyond endurance. The blubber being sliced in great quivering cubes from the monstrous carcase was to yield more than a hundred casks of oil. His ponderous jaw bones when stripped of flesh were five-and-twenty feet in length, and at the root four feet in girth. The giant bones and massy beef boiled and dried and ground to power were to be converted into many a ton of manure. Truly an ignominious ending for these tremendous monarchs of the deep. The shell-like ear bones of a whale exhibit in their serated edge a grotesque caricature of a human profile, and the brawny Norseman who was in charge cut them from the derelict leviathan, and gave them as a souvenir to his visitor.

The return to Vardo was delayed by some lively cod fishing. The fish were big in weight and numbers, and took the bait with such eagerness that their capture demanded more exercise of muscle than of skill or patience. During our absence a little coasting steamer flying the Russian ensign had arrived and was to leave in an hour for the Gulf of Petchenga, across the Varanger Fiord. Petchenga is one of the places of call of the larger Murman steamers which in summer now ply weekly between Vardo and Archangel. Here, therefore, was an opportunity of flight from Vardo and of a visit to the Petchenga Monastery, the northmost in the world. There was certainly a risk of being stranded at the Monastery, but, there one would be away from Vardo and would be able to indulge in the novel experience of being good for a week. The opportunity was fervently seized, and soon after midnight the little vessel passed out from the harbour walls to meet a rolling swell in the broad Varanger Fiord. The pure sea air purged the nostrils, and brought a feeling of infinite relief from the nauseous atmosphere that had oppressed them. If it is true that the sense of smell has the longest memory, then, those who visit Vardo will well remember its reeking stinks when many fairer scenes are long forgotten.

On boarding the Russian steamer in Vardo harbour one passes in a step from Western to Eastern Europe, and is at once confronted with sharp and striking contrasts. When Russia is entered from Norway one finds instead of the firm, confident tread and independent bearing of a race of freemen, the shuffling gait and dull and stolid looks and apathy of the sons of bondage. The little vessel was crowded with Russian deck passengers, men and women, unwashed and ill-kempt, an unsavoury herd, huddled together like sheep without shelter from the miserable rain. They are strangely different these poor Russian mujhiks from the bright eyed, prosperous and thrifty peasantry of Norway. They have a far lower standard, or rather they are without standard of personal cleanliness, comfort and feeding. The contrast is the greater as in these important matters the Norwegian peasantry is second to no other.

Six hours steaming in a lumpy sea, brought us to the Gulf of Petchenga, between whose granite walls we steered a tortuous course to an anchorage four miles from its head. Here lay one of the large Murman steamers, lately arrived from Archangel and Ekaterina: bearing from the former great store of provender for the Monastery, and from the latter, many monks who had been to the official opening of the new harbour. This was the steamer by which after the completion of her voyage to Vardo, my eastward journey was to be continued. But the captain could give no definite information as to when he would proceed to Vardo or when return. He might call at Petchenga on his eastward voyage on the morrow or on the following day.

Two sturdy monks clad in top-boots, coarse woollen jerseys, and tall sugar-loaf caps, manned a small boat and rowed me to the pilgrims' receiving-house at the head of the Gulf. The Monastery of Petchenga stands on the site hallowed by the hermitage of St. Triphon, about fifteen miles inland. The difficulty of the journey across the intervening tundra has led to the decision to remove the Monastery to the shores of the Gulf. The government has granted land, and the process of levelling and brickmaking preparatory to building are now in progress on the chosen site.

The returning monks had already carried off from the receiving station every available horse and telega to drive them to the Monastery, so that no conveyance remained, and the courteous brother in charge of the depot assured me it was impossible to proceed until the morrow. He hospitably fed me on fresh salmon-soup, black bread and tea, and conducting me to a little room—his own—placed it at my service. The room although bare was clean, but on the fresh, white cover of the pillow upon the sleeping bench the erratic movements of certain little black spots were vividly suggestive of what the dark quilt might contain. There was, however, no intention to use the offered couch, for the necessity of catching the steamer which might return to-morrow, meant that the journey to the Monastery must be performed to-day.

The good monk scouted my proposal to cross the fifteen miles of Tundra on foot, and pointing derisively at my shoes (they were in good condition and tolerably stout) laughed "ne-mojsno" (impossible). It is true that he, like all the other monks and pilgrims, wore top-boots, but most of the pilgrims were old men and women, and they were setting out on foot to Petchenga. If the journey was possible for them, it were surely easy for me, especially as two weeks afloat had made me eager for a tramp. My pace at first was brisk, perhaps even a little jaunty on the firm pathway, and I felt the contrast between the spring of my step and the slow and laboured jog of the pilgrims as I passed them—for several small groups after a night at the guest-house had just started on the way. Russian pilgrims are mostly elderly.

Young and vigorous people are not encouraged to go on pilgrimage. There is useful work for them to do. The pilgrims are therefore used-up elderly people, whose backs are bent and limbs are crooked by long lives of hard incessant toil. Soon after outstripping the plodding pilgrims, the firm path ceased and from the crest of the rising ground the vast and vacant tundra doomed by nature to perpetual sterility spread its blighted surface like a dead sea to the horizon. The blank and hopeless desolation and death-like stillness of these dreary Arctic wastes—the deserts of the North—are oppressive, almost appalling. But the melancholy is intensified when the dismal expanse is viewed under the dull grey of a leaden sky, and the spirit of gloom seems to hover over the vacant wilderness. No sign of life invades the lonely land. No song of bird nor hum of insect disturbs the soundless solitude of this very home of silence.

Travelling in any part of Russia at the season when the snows are melting is well-nigh impossible. The roads are only tracks and when softened by the thaw and inundated by the melting snows they become quagmires. Owing to the lateness of the summer there was still much rotting snow, and this track over, or rather through the tundra, was in a condition that could not be described as land, water, ice or snow, but a dreadful compound of them all. Progress became painful and chequered, and would have been difficult even to a crocodile. Now wading and wallowing through liquid marsh, soaking swamp and pasty bog in mud of every variety of consistency; then sliddering over the ice hard surface of the melting snow, and leaping over inky pools, or making detours from the tract in fruitless search for solid ground, four hours were spent in violent acrobatics. And when at last, comparatively dry land was reached my pace had sunk to something like the pilgrim's jog.

Ten miles of open tundra led to a scanty forest of slender and deformed dwarf birches, and here—far within the Arctic circle, and much to my surprise—I heard the cuckoo call. After the eerie stillness of the naked tundra, the cheerful and familiar voice was strangely welcome. Here is one of those trifling incidents that cling to the memory, for now the cuckoo's will always be to me a friendly voice and recall the unseen bird whose companionship I felt in that weird solitude. In this stunted birch wood were large areas under the yellow reindeer moss, and near them the skeleton poles of Laplanders' tents told of visits from these rude wanderers of the dreary waste, who bring their antlered herds to feed. A few half ruined huts of turf and stone, all built by pious hands, stood by the track to shelter way-worn pilgrims.

In the woods I overtook some pilgrims, pathetic little groups mostly in pairs. Heavily, but miserably clad, uncouth and unclean, but gentle in their way and kindly to each other. They would often stop to drink, lifting the water in the hollow of one hand, or would stoop to gather herbs to eat. When the meek are being blessed these poor devotees should be remembered. After traversing the birch woods for some miles the track emerged, and there on a natural plateau in the angle formed by the confluence of two rivers stood the Monastery of Petchenga, the northmost in the world. The journey had been a tiring one, and I could now understand to some extent with what gladness the weary pilgrim must hail the first sight of the domes and spires that mean for him his journey's end, and a haven of rest and comfort for body and spirit.

The guest-house was one of the first of the buildings to be reached. To the left of its entrance is a room for the poorer pilgrims, with broad benches round the walls, where the sleepers lie with heads to the wall and feet towards the passage. To the right of the entrance is a room void of furniture, where the women pilgrims, in every stage of deshabille, lie at random sleeping on the floor, and beyond this, and entering from it, is a room for the better sort of pilgrims, with a table in its centre, and wooden sleeping benches with mats upon them round the walls. A monk of keen perceptions who loitered by the door, recognising that I was not a mujhik, guided me to the room on the right where I met a quaint reception. Imagine a fragile little lady with small, sharp, delicate features and keen eager grey eyes looking out upon you with affectionate interest from behind large spectacles. Her meagre hair is parted in the middle and hangs loosely and lankly on both sides to her shoulders save when her restless nerveful fingers lay it back over her ears. Imagine such a little lady who has lived for sixty placid years in easy circumstances with unruffled domestic serenity, and the deep lines and furrows about whose mouth and eyes are moulded by the habitual expressions of gentleness, and kindliness, and calm. Now place such a slender little lady on two slender little legs, encased to the tiny thighs in tight-fitting top boots, with trousers tucked into them, and you have the monk who entertains the guests at the Monastery of Petchenga. As the creature hovers round the table anticipating every wish, its expression has all the tenderness and much of the pathetic wistfulness of a grandmother watching a favourite child. Its every look and movement was a travesty of femininity, and when it donned its shapka (a tall cheese shaped black headgear with long black veil behind), surely this monk's was one of the strangest shapes that ever son of Adam wore.

No other guest was in the room, and the creature I have indicated—with what in a woman would have been the most winning little ways—laid before me tea and dry black bread. The fare was poor, but never was banquet more graciously and hospitably proffered. For the tea I was truly grateful, but even the sauce of a well earned appetite was insufficient to make the sawdusty bread palatable. While hunger and politeness were urging me to struggle with the prison fare, there entered a well-to-do and jovial looking pilgrim, who immediately from beneath his sleeping bench drew forth a well-stocked hamper, and produced bottles of vodka, and French brandy, and sausages, and smoked and salted fishes, and in the most genial way placed all at my disposal and himself began his meal, while the little attendant monk flitted around and beamed upon us from behind its spectacles. My fellow pilgrim made a false start, for after filling out a decoction of hot tea and brandy, he turned before drinking towards the ikon—or holy picture—as is the Russian custom, and in the act of crossing himself, upset the precious mixture on his clothes. He was a most entertaining and lively old Christian, and having come to make a seven days' stay at the Monastery had wisely brought good store of creature comforts.

Our meal was followed by a stroll around the monastic buildings. Although the monastery is a comparatively small one, the buildings cover a considerable area. They are entirely of timber, and built by the monks themselves. The latest and not quite completed addition was a substantial two storeyed hospital with large and airy wards. The monastery owns many cattle and reindeer, and a few horses, and in a little sheltered valley lay a garden. In all directions the monks were busily employed, working as carpenters, blacksmiths, painters, dairymen, carters, and performing the many minor services required by the establishment. They were mostly clad in coarse grey woollen guernseys, trousers tucked into strong top-boots, and a tall black velvet cap of conical shape like a Parsee's.

As we finished our tour of inspection the church bells rang out over the peaceful scene their call to evening prayers, and just then there appeared in the distance, approaching at a laboured run, an old man and woman whom I had passed on the road hours before. The feeble creatures, their bundles on their backs, and assisted by their long staffs, came on at a sorry trot. Their anxiety was to reach the church in time for evening service. We were in the church when they arrived panting painfully to drop on their hands and knees and kiss the pavement. After much silent prayer, and crossing of themselves, and kissing of the floor, the bent old man opened a little linen bag, and from his scanty store drew out some coppers and purchased two candles—one for himself and one for his wife, the partner of his pilgrimage. With more prayers, profuse crossings, kissings, and ample bows, the candles were lighted and reverently placed before their favourite ikon. All the while the hoarse voices of the monks were intoning the service, and we left the church before it was over. But it was not until long after that the two old pilgrims, who deemed their spiritual needs so much more urgent than their body's, arrived at the guest-house for food and rest. When evening service was over the attendant monk brought us for supper a large bowl of excellent soup with lumps of fresh salmon from the river floating in it. My brother pilgrim and I, with wooden spoons made on the premises, supped from the same bowl. He was rather an untidy eater, but withal a genial comrade.

Owing to the uncertainty as to time of arrival of the steamer, the missing of which would involve a week's delay, I decided after a few hours' sleep to return to the Gulf. My good friend volunteered to arrange with the monks to drive me down. He sent for the master of the horse, or his equivalent, and made a bid which the monk protested was absurdly too little. My agent produced his vodka, and giving the monk half a cupful patted him on the back and told him the bargain was closed. For a monk to take vodka is against the rules, but after furtive glances out from door and windows, the bribe was hastily swallowed, and the erring monk retired. But soon another brother came to plead that the offer was inadequate, and he too was sent away coughing and spluttering and with watering eyes, and so a third was treated before the bargain was accepted. The start was made soon after midnight, but in broad daylight, and a thick drizzle of rain fell through the chill air. The good monks lent me one of their long, warm, grey, woollen coats, with broad leather belt, and whimsically offered to complete the costume with a shapka. Three horses were harnessed abreast troika style, but it took us longer to drive back to the Gulf than I had taken to walk. It was necessary to keep approximately to the track, and the struggles of the clever little horses were pitiable, as they floundered and plunged up to the shoulders in the slough, towing the half submerged tarantass behind them.

The monks at the receiving house on the shore were all asleep, mostly lying about on the floors, and when awakened they flatly declined to get up and man a boat to take me to the steamer's anchorage, four miles away. "It was too early." "There was plenty of time." "Wait and have a sleep." As the steamer might arrive at any moment and go off again in half-an-hour I was in no humour to remain and sleep. And so their boats being far too heavy for one to handle alone, I started to walk to the anchorage by a track leading inland behind the hills that fringe the gulf. Losing the direction in a dense mist, led to many toilsome hours of wading through bog, and mire, and rotting snows, but by great good fortune the anchorage was reached just in the nick of time to catch the steamer. Very tired and very hungry, but more tired than hungry, I sought at once the haven of my bunk and slept till Petchenga was far astern.

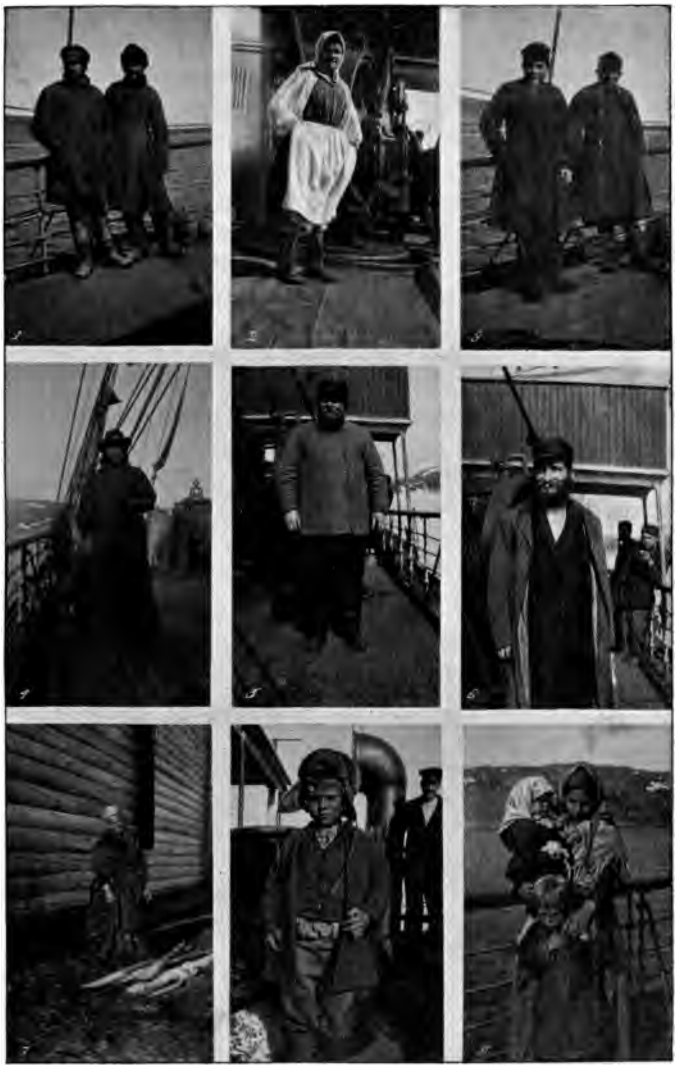
The coast of Russian Lapland—locally known as the "Murman"—fronts the Polar Sea and extends from the frontier of Norway to the entrance to the White Sea. The tail of the gulf stream sweeps round the Northern Capes, and taking an easterly direction keeps free of ice throughout the winter, a belt of sea of varying width. The gulfs and fiords freeze, but the coast nearly to the White Sea although in latitude ten degrees north of the Baltic remains ice-free in winter. The hills of this bleak shore have not the height nor the fantastic grandeur of Norway's rugged coast, but are low and rounded as if they crouched before the terrors of the arctic storms. Their rocky sides are naked save where the untarnished snow gleams from every cleft and furrow and, even in summer, gives this grim coast a cold and wintry aspect. Beyond the projecting headlands dark fiords pierce far inland where dusky hills enshroud the waters in perpetual gloom, and the wild swan builds her nest. On the inhospitable capes no friendly lighthouse with radiant eye gives welcome to the anxious mariner, and no warning sound of horn or bell attacks the treacherous silence when the chill grey fog unfolds its clammy wings and closely broods upon the sea and land.

The vessel glides slowly into the placid waters of the sombre bays or gulfs, and the demon yell of her steam syren bursts upon the stillness startling the tortured echoes from the sullen hills. And at the intruder's summons out from the rocky shores emerge the low dark shapes of Murman boats that crawl with many oars like insects towards the ship bringing their tribute of hides, fish, and oils. The boats are rough and crudely built, and are kept in most unseamanlike disorder. They generally leak, and while the others row, one of the crew must bale to keep the boat afloat. The dwellings too are miserable log huts, but these are mostly used in summer only, for the majority of the fishermen are migrant, and when winter comes this wild coast is almost quite deserted.

Wherever the Russian peasant goes he bears the symbol of his faith—the Cross. And the profusion of crosses rudely formed of timber and often sheltered by a canopy are a striking feature of the cold Murman shores. Over every hamlet perched on the naked rocks stands one or more of the sacred emblems. At every landing place and at the entrance to the bays and fiords the guardian cross presides. When putting out to sea the fishers bare their shaggy heads and pausing to make the sign commit themselves to the divine protection, and on reaching land again give pious thanks for safe return.

The Russian steamers plying along the "Murman" are beautiful fast twin-screw yacht-like vessels extravagantly too good for the traffic. While many fisher folk were carried as deck passengers I was the only occupant of the large and handsomely appointed saloon, but the captain with the natural geniality of the Russian was an excellent and most kind shipmate. The ships are largely subsidised by the Russian Government, and, although the present trade does not warrant the employment of vessels of so expensive type, the aim is to assist development of the fisheries by giving the amplest transport facilities.

This remote province of Russia is in many respects quite un-Russian. There are no soldiers, no passports, no taxes, no customs. The Government that so long neglected the Murman is now encouraging with energy and at much expense its commercial advancement. With the guidance of the Governor of Archangel Province (Englehardt), a man of much vigour and enterprise, every inducement is given to settlers to come and develop the rich



(1) The Murman Fisherman
(2) The Girl he loves
(3) The Tartar who sells him trash
(4) The Priest who marries him
(5) The Merchant who fattens on him
(6) The Jew who bleeds him
(7) The Fisherman's Mother
(8 & 9) His Children

MURMAN TYPES.

fisheries. The electric telegraph has during the last few years been carried the whole length of this difficult coast, linking together the fishing stations. A specially built and handsomely equipped steamer with scientific staff is engaged in submarine exploration and survey work in the fishing interest. Loans are given on easy terms to fishermen to enable them to purchase their boats and tackle, and so evade the extortions of middlemen and Jews. (This measure on account of the insufficient sums advanced is only partially successful). The sale of spirits—formerly a curse to the fishermen—has been entirely prohibited. Medical advice and dispensaries and trained nurses are now available for the sick.

In addition to freedom from taxation the inhabitants are exempt from military service; they are granted free timber from the Crown Forests, and the right to kill fur-bearing animals, and to fish the salmon rivers. But the greatest boon to the fishermen is the frequent and regular service of excellent steamers which afford cheap transport and ready communication along the coast. Between Petchenga and the White Sea there are about thirty fishing stations and settlements where the steamers call and carry to the fishermen salt and necessary provender and comforts, and in exchange load hides, fish, and oils.

The Russian peasant fishermen of the extreme North are very poor, and their thriftless habits are perhaps rather the result than the cause of their poverty. The fishing industry is precarious, for times of long continued storm may come, or the fickle fish may change their haunts and render the season a failure. Then the fisherman—whose reserve if he had any was swallowed up in the previous winter—has the cheerless prospect of another long winter of poverty, and the next season to be begun in debt. But if the Nordland fisherman of Norway, who is subject to the same vicissitudes of climate and fortune prospers, why should not the Russian? It has often been said, and with some truth, that the Russian people are the greatest bar to Russian progress. But one is reluctant to believe that the many splendid qualities of the Russian peasant, his capacity to work, his hardihood, his patience, stoicism, and amazing powers of endurance will not some day help to win for him prosperity. These virtues mostly passive have been fostered by his lifelong contest with ungenial environment and resistance to encroaching poverty. The active qualities he seems to lack—initiative, enterprise, energy, perseverence—would be stifled in any people by chronic poverty. Now much effort is being expended in behalf of these peasants, and with conditions favourable to industry and thrift they will have opportunity to rise if they can to the level of their Norwegian neighbours. The process must at best be gradual, but with material progress may come ambition to the Russian peasant and the consciousness that freedom is his right.

The Laplanders are of a type inferior to the Russians; low in intelligence, stunted in stature, illformed and weather beaten. They have no towns and few villages, but prefer the desolate tundra to the coast, and wander in small groups over the wilderness, living in wigwam-like tents. They fish the lakes and rivers but not the sea, and have only one settlement on the coast. A group embarked as passengers, and the following day being St. Peter's—their patron Saint's—they nearly all both men and women were drunk. Two infants were of the party and luckily for them they were safely ensconced in the light shoe shaped cradles made of reindeer skin stretched on a wooden frame in which Lap women carry their children.

Since rounding the North Cape this so-called "land of the Midnight Sun" had been a sunless land. The sky a uniform pall of dull grey cloud scarce varied its grim tone by day or night save when a pallid lightening of the gloom gave vague suggestion of the sun's position. The cold grey sea flanked by the barren rocks of the forbidding coast and spreading vacant to the North responded with sulky aspect to the lowering sky. Now the weather had cleared and the sun shone out with grateful warmth from a brilliant cloudless dome. The atmosphere regained the extraordinary clearness peculiar to the higher latitudes, and the sea resumed its blue. Even the sun could not bring life to the bleak coast but made it look the sterner by hardening the contrast between the dark and naked rocks, and the spotless white of the glistening snow.

One of the settlements of the Western Murman is Port Vladimir, picturesquely situated in a sheltered harbour land-locked by an island. Here a smart little cutter-rigged coaster—quite un-Russian in her trimness—lay anchored in the smooth waters of the rock-encircled bay. She had just arrived from Novaia Zemlia with a cargo of casks of animal and fish oils, and hides of bears, walrus, seal, and reindeer, the spoils of the lines and rifles of the hardy fishers and hunters, who in summer wrest a scanty livelihood from these inhospitable islands. Her crew was a much beclothed and ill-kempt group of amphibians, but the captain, from his big felt boots to his deer-skin cap was every inch a captain. Not of Slav but of Norse type, he was a magnificent specimen of the bold and adventurous seafarer of the North, and in appearance a worthy descendent of the heroic Vikings. His grand head with fine featured and full bearded face and quick piercing eyes was poised on the massive shoulders of a powerful but alert and vigorous frame. He bore himself without suggestion of swagger, but with the easy confidence of conscious strength, and the habit to command obedience. This masterful mariner, radiant with energy and strong of purpose; the victor in many a wild conflict with an angry sea was the very beau ideal of the skilful daring sailor of the North. As the captain was of a stamp far superior to his crew, so his vessel, dainty as a little lady, looked like a stranger among the clumsy and uncouth craft around her.

Here also two Tartar pedlars came on board with large wood boxes stuffed with the very acme of trash in unlimited variety. Ready-made clothing, rubbishy cutlery, purses, pencils, watches, gaudy ribbons, and gimcrack jewellery were jumbled together. Their tact and persistence as salesmen were rewarded by the foolish fishermen's purchasing of much flimsy stuff that could have been of no possible use to them. One brawny, dirty-fisted giant bought a gaudy bottle of nasty scent, presumably for some short-skirted, big-booted daughter of the shore. The descendants of the terrible Tartars, who for centuries ruled from Moscow, with an iron hand, are found wandering all over Russia in their characteristic costume, peddling haberdashery, and coaxing unwilling kopecks from the simple peasants.

As passengers between the settlements, the steamer carried portly and big-bearded Russian merchants, who traffic prosperously on this coast. The poverty of the fishermen render them easy victims of merchant sweaters, who own many of the boats, and for the service of a crew pay, or are supposed to pay, one-third the value of the catch. The men are often engaged long before the opening of the season, and during the needy winter months the employer advances necessaries. At the end of the summer when the time of settlement comes the fisherman finds his season's earnings swallowed up by previous debt, and is at the mercy of the sweater for another year. It is to abolish this exploitation of the fisher that the government has instituted a system of loans to enable the men to purchase boats.

The ubiquitous Jew was here too in his cheap striped trousers, frock coat, soiled "dicky," and insinuating greasy smile. These cunning and unscrupulous money-lenders find a ready prey in the improvident fishermen who, once entrapped, find no escape from the usurers' crafty toils. But among the unwholesome parasites were other passengers, travelling medical dispensers and Russian Red-Cross nursing sisters. These are ministering angels indeed, for much disease attends the fisher's life of hardship and strenuous work ill supported by poor feeding and bad housing.

The Gulf of Kola pierces Lapland for sixty miles between low hills whose sheltered flanks are clothed with pine woods that give occasion for a busy saw mill. At the head of the Gulf and between the outflows of two rivers stands the town of Kola, for centuries the administrative centre of Lapland and its coast, and a place of exile for political offenders. In recent years the town has shrunk and is now only a wooden village of between three and four score houses. It is condemned to still further decay by the removal this year of the official headquarters to Ekaterina, and will probably soon die of inanition. The silt borne down by the rivers has made the Gulf so shallow that the steamer must anchor several miles away from the town, and this distance is covered by sturdy rowers in the ship's boat.

We landed at the little town at two o'clock one Sunday morning, and the mate, after handing the lean mail bag to the sleepy postmaster, confided to me that the object of his affections was a nurse in Kola Hospital. He had brought a gift for her—a pair of shoddy gloves bought from the Tartars. On reaching the little timber block that formed the hospital, Romeo was in a quandary for he knew not how to waken Juliet without rousing the patients and bringing out the doctor. Whistling serenades were tried and failed, for the fair one proved a heavy sleeper. The receding tide called for our speedy return to the ship, and the tremulous lover steeled his nerves to risk embarrassment by attacking the front door. The noise brought out a dishevelled maid, but the wrong one, and the bashful sailor clearly in an early stage of the malady was half glad half sorry at not being confronted by the one he most wished to see. So leaving the packet with a shy message he beat a hasty and confused retreat.

A peculiarity of Kola is the elaborate system of numbering the houses. There are only a few scores of buildings altogether, but each has four reference numbers painted large upon it. 1. The number indicating the section of the town; 2. The number of the street; 3. The number of the house; and 4. The registered number of the occupant. Even in Russia this is quite exceptional.

Above Kola on the Tulema river some English salmon fishers have in recent years camped for the season, arranging with the Laplanders for the right to fish. Later I met two others en route to Kandalax, and at Archangel one bound for the Petchora. One cannot help admiring these manly sportsmen whose enthusiasm survives months of hardship and privation, and who feel rewarded by the pleasure of killing with rod and line a score or two of heavy fish, or shooting an occasional elk or bear. Only our country produces this type, and it does well to produce them, for they are of the breed that have built up our Empire over seas and have energy to maintain it.

Ekaterina, the new seat of government of the district, and Russia's first and only ice-free harbour lies in a sheltered bay of the Gulf of Kola, twelve miles from the sea. The opening ceremony had been performed by the Grand Duke Vladimir the week before my visit. The official opening of the port was hailed throughout the country as an event of great national importance. So far as I was able to judge, however, the new harbour will have little political influence. An autocratic government can by lavish expenditure achieve much, but the natural disadvantages of Ekaterina as a naval harbour are too serious. The inaccessible rocks afford no lodgement for workshop or naval depot. The harbour is too limited in size, too remote both by sea and land, and although a railway (which would be a very costly one) is projected, its existence would not materially add to the naval value of the port. Russia for lack of an open sea board has hitherto been powerful only on land, but now her landward conquests have led her almost within sight of the open seas, and the recent building of a powerful fleet is an index of the trend of her ambitions.

It is significant that communication with the outer world was not opened by the Russians from within, but by foreigners from without, and it has been left to another Englishman—Captain Wiggins in our own time—to realise the dream of the unfortunate Willoughby by opening through the Kara Sea a trade route between Europe and North Asia.

The new town of Ekaterina affords an excellent example of the methods of an autocratic government. No gradual or natural growth was here. It was decided to have a town at this point, so a town was ordered. The buildings, a church, bank, school, hospital, telegraph office, police station, and other official buildings, and stores, and whole street full of dwelling houses—all of timber—were built at Archangel, the logs marked and taken apart, and shipped and re-erected like Chinese-puzzles *in situ.* There was no room to build a town beside the harbour, but a site was chosen on a plateau on the hills above. The appearance of the little town was distinctly novel, for *every thing* was quite new and looked extremely smart.

One or more of the Murman steamers winters in Ekaterinà, and in spring, before navigation is open in the White Sea, resumes its coasting journeys to the westward, and then works eastwards to the White Sea and Archangel as the breaking ice permits. The fishermen, who at the close of the season desert their settlements proceed by steamer to the Onega district and west coast of the White Sea to their homes and women folk. Early in Spring, before the snows melt, many of the fishers return on foot, travelling hundreds of miles overland dragging small sledges with their belongings to the coast. Until recently this was the fishermen's only means of reaching the coast, but the new line of steamers largely obviates the necessity for this toilsome journey, and enables many women to accompany their husbands. The number of families who remain throughout the winter grows yearly, and will continue to do so as the steamers destroy the sense of isolation which formerly must have been acute.

In this region the keeping of irregular hours is not an indication of dissipation and one sleeps when he feels inclined, without respect to the clock. Owing to the monotony of the coast there was opportunity between the stopping places for sleep, but at the settlements all were awake. One could either remain on board and lazily watch the loading of bales of hides and casks of oil, or go ashore and stroll among the racks of drying fish, and see the fishers mend their nets or lines, and boil cods' livers in huge tanks.

A few days sunshine on the Murman is often followed by a fog. And so it fell with us when a strong north-east wind, blowing straight from the neighbouring ice, moisture-laden and bitterly cold, unrolled the fog upon the sea and blotted out the sun. Under these conditions navigation is suspended, the engines are stopped, and everybody goes to sleep, for no attempt is made to approach the dangerous coast when the weather is thick. So the ship, dripping with moisture from the weeping fog, wallowed like a lifeless log upon the sea for two and twenty hours, while all but a watchman slept. The long unbroken sleep is welcome after a week of scrappy rest. For the settlements where the interest centres, are frequent, and the intervals for sleep are short, and sometimes sacrificed to watch the gambols of occasional whales, and near the shore, the herds of seals.

When the cold wind died and the fog cleared there followed days—nightless days—of brilliant sunshine and perfect calm. In the tropics the sun at evening plunges nearly vertically from the sky into the sea, leaving almost instant darkness in its wake, but in summer in the far north, he trails slowly, at a long angle, towards the horizon, and at midnight seems to hover over the sea-line ere mounting again the path that begins another darkless day. There is an indefinable charm in the limpid purity and transparency of the atmosphere in high latitudes, and at midnight, when the sun is low in the north, and the shipless sea spreads to the horizon a molten ocean of gold under a flaming canopy of gorgeous colour the voyager is held spellbound by the unearthly beauty of the scene, and with his back to Europe and the terrestrial world; facing the silent North, while the unsetting sun completes its majestic circle he gains a vague impression of being on top of the world, and gazing straight into the infinite mysteries of space. On such a glorious Arctic night, whose memory lives and lures the fascinated voyager back to the enchanted region, we rounded Cape Sviatoi Nos (Holy Cape), and in a breathless calm entered the White Sea. Soon we steamed into the midst of many ice floes—the outposts of pack ice beyond. The floes—borne gently northward by the current—were large and of most fantastic shapes. Their reflection of the delicate colouring of the early morning gave them a ghostly aspect, and the strange mirage and false horizons (caused by refraction) increased the sense of unreality. There was something solemn in the stately progress of this phantom crowd towards the weird solitudes of the Polar North. These ice floes in the White Sea's throat were carried thence from the Kara Sea by north-east winds. The White Sea winter's ice was gone, but ice fields driven to the south had, till three days before our passage choked the narrow entrance of the sea and caused great damage and delay to the steamers bound for Archangel. On emerging from the straits, the ice was left behind and the sun blazed down from a cloudless sky and the White Sea spread like a circular mirror of boundless size.

The steamer makes one more call—at Zolotitza—on the Winter (eastern) coast and then heads for Archangel river.

At the bar of the Northern Dwina, thirty miles below Archangel, the huge war vessel lay that brought Grand Duke Vladimir from the Murman coast, and anchored near her was the Polar Expedition ship of the Duke D'Abruzzi, the latter taking on board 120 Siberian dogs and an equipment of furs for the explorers. Their flagpoles bore the ensigns at half mast, but only when we reached the port we learned the national significance of the mourning sign.

The Tzarewitch was dead. In the far Crimea the heir to Russia's sceptre had come to a tragic end, and died in a stranger's arms. The death of the young Prince was known in Archangel for some days before the official announcement was made, and in the interval many strange rumours and mysterious whisperings were abroad as to the circumstances. In a country where the press is under strict survelliance, rumour is always active, and at this time, while the government withheld intelligence of vital import to the nation, the people were uneasy and suspicious, and eager to listen to the most improbable tales. When the official news did arrive it was inconsistent with accepted versions of the event, and there was a prevailing idea that something was being concealed. The sense of mystery was intensified by the fact that no Russian flags were shown at half-mast (nor at all) in Archangel. "The police had not given permission." Only the foreign flags over consular buildings were up. A special service was announced to take place in the Cathedral, and official invitations were issued. But at the hour appointed no priests were there. The only explanation was that permission had not come from St. Petersburg and without it no service could be held. It is probable that these incidents had no significance, and were due to official oversight. But the impression was about that the whole truth had not been told, and this mistrust bred sinister suggestions.

Of recent years the channel from the bar to Archangel has been deepened, so that steamers now load and unload on the river abreast the town, instead of outside the bar as formerly. Archangel spreads along the level banks of a branch of the delta of the Northern Dwina, thirty miles up from the bar, and while yet a great way off, the spires and domes of the Cathedral of the Archangel that dominates the town rise from the low and wooded sky-line. Here ended the long coasting voyage in which, since leaving Bergen—a distance of more than 2,000 miles—the land had scarce been out of sight, save when obscured by fog.

By the route opened up by Richard Chancellor, Archangel and the Northern Dwina were once the main channels of foreign commerce, but when Peter the Great opened Russia's window to the Baltic the trade was diverted and Archangel doomed. It can never now attain the relative importance, which at one time seemed assured to it.

At Solombol, as the lower portion of Archangel is called, great saw-mills skirt the river, where steamers load timber and square miles of rafts floated from the interior line the banks. The air is filled with the rumbling of logs, the clanking of planks, and the whirr and screech of circular saws rasping through the tortured timber. The atmosphere ashore is permeated with sawdust, and the ground is inches deep with wood refuse and decaying timber. A score or so of ocean tramps lie at anchor on the broad river, hoisting flax and jute from barges tethered to their sides.

Being warned to avoid the inns at Archangel, I obtained what were recommended as the best quarters available in Solombol. But the unnameable pests that infested the floor and walls and bed resented my intrusion. The quilt upon the bed looking too suspicious was removed, and when lying down with face to the wall to avoid the light, I seemed to see the surface of the wall in motion and rubbed my eyes. But so it was. Recoiling with the bed to the middle of the floor away from that awful wall I tried again. But rest was impossible. The remembrance of that chamber of horrors fitly decorated with a photograph of the corpse of the proprietor's deceased wife raises an irrepressible shudder. In addition to the loathsome creeping and leaping things were the mosquitos which breed upon the marshes near. And the verdict of the ship-captains was that the Archangel mosquitos were the largest and fiercest of their kind. Only one of them knew of a place where mosquitos were larger or more savage, to wit, "Mosquito Creek in the Gulf of Mexico—where no white man could live."

After two nights of torment, the captain of a ship that lay out in the river loading jute for Boston, cordially offered me a refuge in his spare cabin. His hospitality was most welcome, and out on the river we were almost free even from mosquitos. The days of waiting for arrival of the monks' steamer which carries pilgrims to Solovetsk, were enlivened by the companionship of about a dozen captains of "tramp" steamers who had brought their vagrant vessels from the uttermost ends of the earth to anchor in this broad river, and load timber or tar or jute, and to disperse again to plough their lonely furrows through the seas in directions as diverse as their number. They were an interesting group these sun-tanned, mosquito-blistered, much-experienced mariners with their wide-world tales of shipwreck and disaster, of peril and privation. Skilful navigators, too, accustomed to guide their ungainly cargo tanks to little-known and badly-charted coasts, and equally ready to do battle with fierce typhoons in the southern seas, or to grope a precarious path among the jagged ice fields of the polar north. Their ideas of discipline impose upon them while afloat a lonely life, and their leisure is spent within the sacred confines of their narrow cabins. When in port and the day's worries are over, it is not surprising that they who have so much in common should foregather, and, amid more or less restrained conviviality, awake memories of distant harbours and bygone shipmates.

These ocean wanderers are a different breed from the gilded officers of the great liners who only navigate their ships from port to port, and whose responsibility ceases when the dock gates are reached. When a tramp reaches port her versatile commander lays down his sextant and takes up his ready reckoner, for ashore he is his "owner's" representative and man of business. He must negotiate for the discharge of cargo, payment of freight, purchase of coal, water and provisions, payment of stevedores and harbour dues, and a thousand other details, such as conciliating dock masters, bribing customs officials, paying fines for the release of unruly members of his crew, getting work out of the lazy, and doctoring the sick ones. Tactful, recourseful, self-reliant, their courage schooled by many emergencies, and their shrewdness by wide experience in dealing with men of every race and colour, these gipsies of the seas are in a big sense "men of the world."

Not less interesting as a type are the engineers who thrust the sluggish tramps through storm and calm over the highways and byways of the sea. Scotsmen or Tynesiders most, firm knit, strong handed men, quiet and imperturbable, but on occasion capable of the most strenuous energy and unyielding tenacity; men who are at their best when opposed by difficulties, and in whose vocabulary there is no "can't." The flashing gear and plunging cranks are their companions while on watch. They have a proud affection for their ponderous charge, and know its every mood and understand the language of its sounds. When all runs well the tireless engines murmur their content to him, but his vigilant ear is quick to hear the grumble of a valve or the whisper of a thirsty rod for oil. There is an almost universal feud between the engineers and the deck officers, for the man who drives the ship has at best a tolerant contempt for the man who only "keeps her nose straight." If the ship is badly steered and leaves a crooked wake, the engineer who drives her feels aggrieved and makes no effort to conceal disgust, and when the first mate sees a spoor of greasy footprints on a clean washed deck his indignation must have vent, and a hundred other little points of friction stir the smouldering feud taxing the captain's tact to keep the peace.

At Archangel is a large State prison for long sentence convicts. Some are political prisoners, but the great majority are criminals, including murderers, for there is no capital punishment for civil crime. Much has been written in England of the horrors of Russian convict life. But I have seen convicts at outdoor labour in many parts of Russia, and it is beyond question that the conditions of convict life and labour there (in European Russia) are immeasurably less severe than in this country. There is a system of hiring out convicts for daily labour, each gang of twenty being in charge of one armed warder, and every man receives a small proportion of the pay. In Archangel the loading and coaling of ships is done chiefly by convicts, but soldiers who are also hired out, and many women labourers are also employed. On some ships all three classes of labour were working together in the holds.

The convicts work the same hours as the soldiers and cannot be more plainly fed. They have a quite extraordinary amount of freedom, and do as little work as possible, rather lazing or sitting about smoking cigarettes or watching for opportunities to thieve while their soldier warders sleep. The guardianship is so absurdly lax that escape would be easy, and it is significant of the extreme docility of the Russian and his awe of authority (or it may be content with his conditions), that escape is rarely attempted. If such methods were adopted at English convict stations, the convicts would all be missing in a week.

While at dinner one evening with my host, the captain, we heard a commotion on deck, and the steward, who was sent to ascertain the cause, reported that two barge loads of convicts had left the ship for the prison, but the convicts belonging to the third barge could not find their warder, and a search was in progress. He was ultimately discovered in one of the holds sleeping soundly on a bale of jute. Such occurrences are quite common. In addition to the convict exiles there are in Archangel Province many political exiles who within a prescribed area are free to come and go and to earn their living as they can, and in the long dark winter have ample leisure for reflection upon the limitations to the expression of independent thought imposed by the Government of the Tzar. One of the steam winches on this ship was for loading purposes worked by such an exile; a man of education who had been on the staff of a Moscow newspaper, but whose progressive opinions brought upon him the disfavour of the police and banishment to this distant province.

My objective Solovetski Monastery—one of the most famous in Russia—is situated on an island in the White Sea, about 200 miles to the westward of Archangel. The Monastery owns two steamers manned by monks that ply between Archangel and the island carrying pilgrims to and from. The monks do not adhere rigidly to any time-table, but a steamer generally leaves twice a week from Archangel. For some reason the mid-week steamer did not arrive from the monastery and this caused six days delay. At last she did arrive, but on going to the landing stage half-an-hour before the time announced for her departure, I found her already crowded, and on the shore a large concourse of disappointed pilgrims for whom there was no room. Owing to the failure of the mid-week steamer, an exceptionally great number of pilgrims had accumulated, and overflowing from the guest-house on the wharf many had slept for several nights in the open. My attempt to go on board was checked by a very hairy monk who demanded my ticket, and not having one he directed me to the guest-house where tickets were issued. In the hall there stood a stalwart monk who towered like a lighthouse over an impassioned and gesticulating crowd that surged around him. He maintained a posture and expression of absolute impassivity before a storm of appeal from excited pilgrims tendering their roubles and beseeching tickets. It was clear the ship was booked full and no more tickets could be sold. Many anxious creatures were in great distress, and some of the well-to-do pilgrims stormed vehemently, but ineffectually. Although the outlook was unpromising there was a chance the monk might stretch a point in favour of a stranger. But my request was met by an abrupt and decisive "ne mozno" impossible.

Returning to the wharf I managed to send my bag on board, and then gained the steamer's deck by strategy. When the propeller began to move so did the pilgrims, and for several minutes they continued to cross themselves and bow towards the churches on the shore. My fellow passengers were a motley crowd and packed so closely that not a square foot of standing room was left. The elder women were mostly clad in sombre gray, but the younger ones wore the bright colours that are dear to the Russian peasant. Some wore top boots and others bast or birch bark sandals. Most of the men were poorly clad, and many were tattered and travel stained, and when crouched to sleep looked mere bundles of rags and whiskers.

Each pilgrim or group produced from their canvas haversacks bread, cucumbers, tea, and some even cheese or dried fish, and filling their own tin kettles at a large hot water tank provided on the steamer, prepared their evening meals. Mothers squatted with their squalling infants, and with scant elbow room performed rites that elsewhere are sacred to the precincts of the nursery. Wherever a crowd of Russians can find room to stand there also will they find room to kneel, sit or lie. And as the night-long evening fell on the lone White Sea the pilgrims crossed themselves and sank in huddled heaps upon the open deck to sleep.

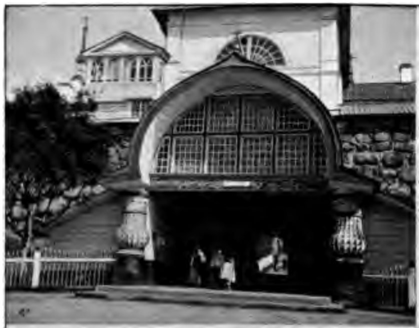
To a foreigner there was much of interest in this full cargo of pilgrims—Bogomoltsy or God-worshippers as they are called; a throng truly representative of Russia, gathered together from the wide plains and dense forests, from the tundras of the north and the deserts of the south, from Europe and Siberia, to worship at the shrines of Solovetsk. Among them were many invalids, with wasted frames and feeble limbs; mothers with delicate children, pinched by sickness, big-eyed, pale-faced and languid, all urged by strong faith and sore need to the shrines whose miraculous cures are famed all over Russia.

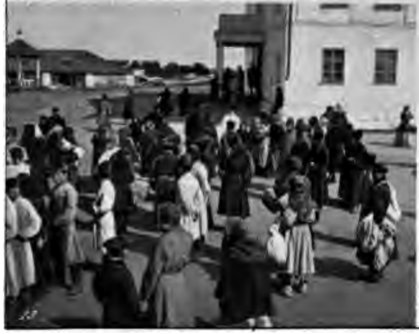
Down below, the stuffy little cabin was packed with pilgrims of more prosperous sort, for there are first, second and third class on the pilgrim steamers. The women, some with families, were clothed in black, and with them men of the small merchant class. Gentle, genial folk are these, who quickly give a stranger kindly welcome, and round the samovar with frank but unobtrusive friendliness, soon make him quite at home with them.

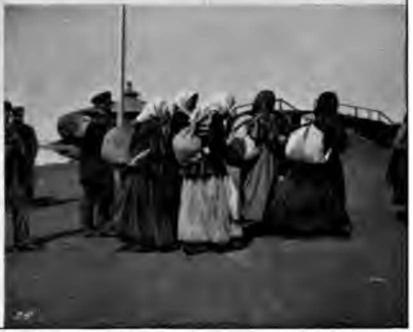
One careworn woman had brought a fragile little daughter, gripped by some mortal malady. The suffering girl seemed in the last stages of disease, and with the slenderest hold on life. There was a great pathos in the infinite tenderness and love of the mother's nursing and fondling of her feeble charge, twining her protecting arms around her, and clinging to her as if she dreaded death would wrench her child away. Later, I often saw this poor woman lead her passive charge from shrine to shrine, and surely none prayed with more fervour. When leaving the monastery, her route and mine were the same until in Central Russia, at Yaroslav, a thousand miles from Solovetsk, our paths diverged, and I know not how much farther she, with her ailing girl, travelled to her home. Let us hope the saints of Solovetsk have heard this mother's prayers and saved her much-loved child.

About nine o'clock next morning the islands, as a low dark strip of land appeared upon the horizon of a glassy sea. As we approached the pine-clad shores, all eyes were strained for the first glimpse of the monastic towers, and the pilgrims were hushed with the stillness of strained expectancy. Soon a change in our course reveals, emerging from the sombre trees, the cluster of still distant domes and spires which crown the famous cloister. At this first sight a deep strange murmur of voices, subdued by reverence, passes through the eager crowd, whose wistful, longing gaze is fixed upon its journey's goal. Then a brisk commotion stirs the throng as each pilgrim, with many crossings and low bows, salutes the sacred pile and silent prays. At reduced speed the vessel is piloted through a shallow and tortuous channel until a landlocked bay is reached, and near its shore rise the battlemented walls of the old monastic fortress, and towering high above them the bulbous domes, and belfries of the chief cathedrals.

The monastery was founded in the fifteenth century, by a hermit monk, Savaatii, who sought seclusion in the desolate Isles of Solovetsk. Savaatii's successor, Zosima, built the first church at Solovetsk, and attracted to the hermitage other pious monks whose ideal of a holy life was the austere existence of the anchorite, and so the Solovetski brotherhood was formed. The growth of the monastery and expansion of its influence was greatly due to a noble of the court of Ivan the Terrible, who, renouncing







(11) Holy Gate at Solovetski
(12) Tame Glaucus Gulls in Courtyard
(13) Pilgrims and Monks near a Guests-house
(14) Pilgrims arriving at the Monastery

AT SOLOVETSKI MONASTERY.

rank and wealth, journeyed as a pilgrim to the shrine, and remaining as a monk became in time its Superior. The powerful personality of this remarkable man, and the saintliness of his life brought such spiritual prestige to the cloister, that its fame spread throughout Russia, and attracted streams of pious pilgrims and rich offerings to the shrines. The splendid cathedrals were built under the regime of the monk Filip, who also inaugurated and organised much of the industrial work which is still a feature of the monastery. The massive battlemented walls of Solovetsk were in the middle ages the stronghold of the Muscovite faith and nationality, and in the stormy days of Swedish invasion, were Russia's ramparts in the north. In times of stress the sturdy monks, reinforced by military commanders and men, often held the encroaching Swedes at bay, and in more recent times the venerable fortress withstood the attack of British gunboats during the Crimean war.

On this calm morning the rugged boulder walls and lofty spires crowned by golden crosses, were mirrored in the placid waters of the bay. And as the vessel glided slowly towards the shore, the monks in sombre black, and the lay brothers in coarse white linen cassocks, broad belted at the waist, gathered at the landing stage to welcome the strangers who had journeyed from the great world with the common purpose to worship at the shrines of Solovetsk. Soon the vessel is moored. The voyage is ended. The pilgrims' bourne is reached, and again, with many fervent crossings of themselves, they sway in their obeisances to Solovetsk the Holy. Then, with their bundles on their backs, the zealous throng swarms to the shore and quickly mingles with the hermit crowd. The monks alloted the newcomers to the respective guest-houses, sending those who looked the most unclean to the older timber buildings, and the others to a large three-storied white-washed barrack. A burly anchorite, shouldering my valise, led me to the latter building, where the long and spacious corridors were thronged by newcomers, and the attendant monks with tolerant good humour, were assigning chambers to the impatient pilgrims. The rooms were of good size, whitewashed and scrupulously clean. Round the walls stood sleeping benches, four, five, or six in number, and by the windows a table, that like the chairs was scrubbed. My room mates were a Moscow merchant and his son, and two youths on holiday from Onega.

The travelling Russian carries his bedding with him, and this is often the bulkiest portion of his baggage. Those who can afford it carry fresh sheets and pillow covers, in addition to covering quilts, and all prepare their own couches before retiring. Hotels and inns in Russia, except those that cater for foreigners, provide merely sleeping benches, with mattresses of varying degrees of hardness and lumpiness. Each traveller must bring with him whatever additions he requires for his personal comfort, and he generally carries his own provisions, asking only to be supplied with hot water. A Russian's journey is a kind of picnic with a purpose. Many of the better class pilgrims brought food with them, but they too shared the pilgrims' meal at the refectory. The pilgrims are fed twice daily, at eleven o'clock in the forenoon, and at eight in the evening. As these hours approach, the hungry pilgrims congregate outside the closed doors of the Cathedral of the Assumption, and throng the spacious corridors. In the far north of Russia the churches are built in two stories. The upper is the "Summer Church," and the lower the "Winter Church." The principal refectory at Solovetsk is the Winter Church of this Cathedral, and a magnificent dining hall it is. The walls and the groined ceiling that rests on a great central pillar, are entirely covered with ancient mural religious paintings of grotesque dimensions. Punctually at the appointed hour the great gates are opened, and the men are admitted first. After they have reached their places, filling the great hall, the women stream through to large whitewashed dining halls beyond, where they are separately accommodated. Along each side of the narrow tables a strip of coarse but clean unbleached linen cloth is laid, and for every pilgrim a large piece of heavy black bread, a tin plate, and a wooden spoon are provided. Down the centres of the tables, at short intervals, stand tin basins filled with quvass,* in which tin ladles float, and between them tin plates of green onions and chopped cabbage raw. The monks are at separate tables, but the same fare is served to all. At a table across the end of the refectory is the Archimandrite, or his deputy, who presides, and the senior monks. A silver chain from a bell overhead hangs within the Abbot's reach, and when all are standing at their places he strikes the bell, and the deep throated monks chant grace, and ere they sit he blesses the assembled multitude.

Although the food is coarse, it is wholesome and abundant. The following is an example of the menu for the morning meal, which consists of four courses. 1st, chopped raw vegetables, of which some make cold soup by mixing with quvass. 2nd, Thick fish soup in which lumps of salt fish float. 3rd, Thick vegetable soup. 4th, Casha—a kind of brose served with butter and milk.

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* A sour non-intoxicating beer made from rye.

The evening meal is similar to the morning one, but only two courses are served. When the pilgrims have seated themselves, the bell is sharply struck and immediately a monk, perched in a little pulpit, begins to read, in a loud voice, from some sacred book, and so continues until the meal is ended. This bell is also the signal that the pilgrims may begin. After time has been allowed for the first course the bell is again sharply struck, a wide door is promptly opened, and with the rapid clatter of many feet, a double stream of lay brothers enters, each bearing before him a large tin basin of steaming broth. The basins are laid at such intervals that every pilgrim can reach one, and five or six wooden spoons hunt for the tit-bits in every bowl. When one wishes to drink he seizes the tin ladle in the nearest quvass bowl, and from it slakes his thirst. The third and fourth courses are similarly served. There is no hurry, no bustle, no waiting, and the function is conducted with the most perfect promptitude and well ordered smoothness. At the conclusion of the last course a double stream of cassocked and booted long-haired boys, carrying capacious baskets, enters to gather up the fragments. The fragments are many, for few even of the hungriest of the pilgrims can swallow the whole of the brick of black bread. Then the chief priest dispenses the communion to the monks who, while the people stand, bring round, on trays, small cubes of consecrated bread and every pilgrim has a piece. Thanks are chanted by the monks, the people are blessed again and the proceedings are terminated by the broad-whiskered white-cassocked chef, who enters and gravely bows, first to the monks, and then to the people, and finally kissing the abbot's hand himself receives a blessing. The feeding of so great a community, so far from any base of supply, and the provisioning of the monastery for the eight months' winter must require most skilful stewardship.

Profiting by my experience at Petchenga, and the example of my friend the pilgrim there, I had brought from Archangel a supply of solid and liquid rations. But in a few days these were exhausted, and even the embarrassing hospitality of my room-mates, who also came provided, did not prevent my longing for a meal that I could eat with relish. The very abundance of the coarse fare at the refectory raised ones gorge, and each meal was looked forward to as a time when a quantity of disagreeable medicine had to be taken. Unfortunately, I did not have the satisfaction of believing that hardship was being endured for my soul's profit.

On the last day but one of my stay at the Monastery, there was no forenoon banquet at the refectory, for this was the anniversary of the bombardment of the Hermitage by British war vessels, and was given up to prayer and fasting. During the Crimean War a British admiral demanded the surrender of the monastic fortress. This the doughty monks refused, and from their small three-pounders opened fire upon the ships. Their guns were soon silenced, and the monks had no resource but prayer. They formed into procession and chanting prayers walked round their massive walls, while shot and shell fell thick around them. Owing to the shallow water the British ships could not approach the shore, within effective range, and after two days' futile bombardment of the impregnable fortress, took their departure. Although a large number of shells fell on and in the monastery no man, nor even a gull was hurt. The last shell fired by the wicked English happened to strike the large mural painting of the Madonna and child on the outer wall of the chief cathedral tower. The monks attributed the immediate cessation of hostilities to the miraculous interposition of the Virgin, and the hole where the shot entered the sacred picture is preserved as evidence of the Divine intercession. The monks show with pride many holes caused by shells in the various buildings within the fortress walls, and the damages have only been repaired where structural safety required it. The incident brought little credit to the English, but the manifestation of God's special favour and protection gained great glory to Solovetski's shrines. Now the monks commemorate the two days' siege upon each anniversary by a day of fasting followed by a day of feasting and processing round the walls. So for the sins of my countrymen I fasted one day, being allowed only a meagre meal of raw cabbage and quvass. And to make matters worse I had left the islands before the morrow's feast was spread. On the anniversary day, services had been in progress since early morning, and the vaulted churches and corridors rang with the thrilling sweetness, and crystal clearness of the boy choristers' chants, or echoed to the thunderous grandeur of the tremendously powerful bass choirs. There is no music but of the voice in Russian Churches. But now the pilgrims flocked to the principal cathedral where the most important function of the day —a service in commemoration of Savaatii, the patron saint of the Hermitage—was to be held. Under the ample dome, and surrounded by the oriental colour and golden splendour of the venerable church, the pilgrim worshippers, in the dim light, gathered at Solovetski's Holy of Holies—the tomb of its sainted founder. Out from the base of the hallowed shrine that sparkled in the light of the myriad tapers clustered round it, about thirty of the chief priests stood in two converging lines, forming the letter V. At the apex was the Archimandrite (or Abbot) in rich robes of crimson and gold, wearing a massive jewelled cross, and a much bejewelled mitre. The attendant clergy's raiment was of gold-embroidered yellow, with silken lining of bright pink, and each held, clasped by both hands, a tall wax candle. When chanting the responses, these priests knitted their shaggy eyebrows in the effort to summon their deep bass resonant voices, as it seemed, from the depths of the big top boots they wore.

The day was hot, the prayers were long, and the fumes of the incense were heavy, and some of the older priests who had been officiating since early morning became drowsy. When the abbot read from the sacred books the sonorous monotony of his voice lulled one of his drowsy retinue to sleep. When the monk began to nod so did his tall candle, and with each nod it drooped more near the horizontal, and the grease dripped to the floor. At a friendly nudge from his neighbour the monk awoke with a start, and the candle regained the vertical. Again and again he nodded, and the tell-tale signal drooped forward out of line, and the grease upon the floor. But this little touch of humour was strictly local, for the whole environment was such as to deeply stir the religious sentiment of the impressionable pilgrims. And the ecclesiastical pomp and the grandeur of the imposing ceremony held the worshippers awed and spellbound.

Here at last they stood in the heart and kernel of the cloister; in the very presence of the sacred relics, and fronting Savaatii's tomb—for many the ultimate goal of long and weary pilgrimage. Waves of profound religious feeling seemed to agitate the congregation as at intervals they bowed devoutly, and crossed themselves with solemn gesture. When the Archimandrite in ponderous tones boomed forth the lengthy prayers in which the oft repeated long drawn name "Savaatii" recurred, the people knelt in the most rapt devotion; women old and young, and big, uncouth, rough-bearded men were moved to tears, and sobbed in their emotion.

An impressive sight and typical of Russia was this vast kneeling gathering of the Orthodox, whose strong faith and intense religious feeling is unmatched in Western Europe, where such simple unquestioning faith is out of date. It may be that the Russian peasant's religion is largely superstition, and that he accepts his fathers' creed because too ignorant to be sceptical. But the Orthodox religion is a vital power in Russia, a bond of union to the people, and the strongest guarantee of social and political stability. For their patriotism and religion merge in their love for Holy Russia. Surrounded by nations of different creeds, the Russian religion and nationality are bound up in each other, and disloyalty to the one means disloyalty to the other. As head of the State, and guardian of the Faith, the Tzar enjoys the filial devotion and deep rooted loyalty of his peasant people.

After the commemoration service I remarked to an old lady pilgrim with whom I had become acquainted, upon the intense devotional fervour of the worshippers. "Ah," she responded in a tone of conviction that would have rendered doubt ridiculous. "No other can pray as prays the Russian." It is certain that few Christians pray as pray the Russians. But this good lady did not agree that religion should be closely associated with morality. "Religion," she said, "is a thing apart, and does not admit of reasoning, it is of the heart alone, not of the head." A creed which elsewhere is widely adopted, but less frankly avowed

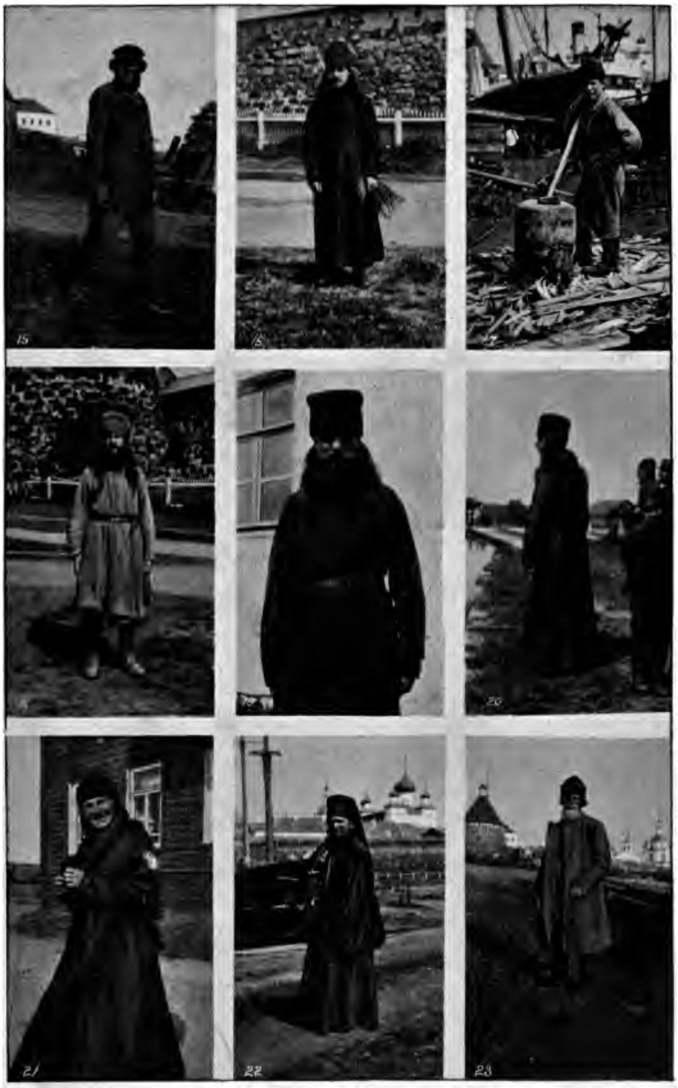
This old lady had overjoyed me some days previously by addressing me in English. She proved to be most entertaining company, a much travelled, widely informed and most intelligent gentlewoman. At first she was briskly bubbling over with a grievance. On arrival she had been consigned by an attendant monk in the guest-house to a room which she was to occupy in common with two married couples. Her indignant protests were unheeded by the stolid monk who saw no ground for her complaint. Only after appeal to a higher functionary was she more suitably accommodated. The views of the monk may be partially explained by the fact that it is not the custom of Russians to entirely disrobe at night. They sleep in a portion of their day clothes, and the sleeping benches are hard couches rather than beds in the Western European sense.

My new friend was of the old Russian conservative stamp with a passionate love and loyalty to the Imperial Family. The fervour of her devotion to the Tzar was in its strong sense of personal affection and attachment like that of the Scottish Jacobites to the Royal House of Stuart. During the illness of the last Emperor this old lady made a pilgrimage (as did many others) to Jerusalem to pray for his recovery, and she told with emotion how on the morning of her arrival at the Holy City she heard of the death of her beloved Tzar. But the strength of her fidelity to her country and its throne was surpassed by the intensity and venom of her hatred of Germany and its Kaiser. In her unreasoning vituperation of Germany and the Germans she became a little fury, and gave voice to the most fantastic calumnies and absurd delusions; physically exhausting herself in the vehemence of her denunciations.

Among others—and she solemnly "staked her head" on this—that the late Tzar died of poison administered at the instigation of the present Kaiser. She "prayed God that although an old woman she might live to see the Russians and the Germans fight." On my mildly protesting that these sentiments were not becoming in a devout follower of Christ, nor consistent with her rôle of pilgrim to this sacred cloister, she burst out afresh, but in language quite unprintable and in response to my interjection that "God made the Germans as well as the Russians," she concluded with explosive emphasis:—"God did not make the Germans!" "God could not make such people!! The devil made the Germans!!! Oh! such people!!!" And with this last effort her poor strength was spent. On all other matters her varied information and keen intelligence made her a most instructive and delightful companion, but the subject of Germany and the Germans was afterwards avoided. These vapourings of an old lady would be unworthy of reference were they not an expression, although grossly exaggerated, of the attitude of a large class of Russians towards their Western neighbour.

During the short summer at the monastery all is bustle and activity in the day time. The carpenters' axes are plied in the busy dockyard, and the anvils ring to the stroke of the hammer. The steamers disgorge their cargoes of provisions for the winter, and sacks and casks by hundreds are hurried by the willing hands of novices from the wharf into the stores. Here, new buildings are in progress, there, repairs. Some white cassocked novices cart building materials, others cart water, and on the shore the fisher monks repair their nets. In the monastic workshops within the walls cloth is woven, clothes are made, leather is tanned, boots are made. Coopers, cap makers, candle makers, net makers all have plenty of work to do. In a large studio, artist monks paint and gild the holy pictures that decorate the shrines. A brewery reeks where quvass is brewed, and at the bakery ovens and kitchen cauldrons, bakers and cooks are busy, for the mouths of a thousands monks and twelve hundred pilgrims must be filled. But nearly all this work is done by lay brothers and novices of whom there are about six hundred. Pilgrims to Solovetsk often renounce the world and remain for years at the monastery giving their labour to the monks, and many end their days as lay members of the brotherhood. Others come to work as penance, or to fulfil a vow, or for relief from sickness, or in gratitude for health restored, or answered prayer. But a large proportion of the lay members are boys and youths. Many are sent by their parents for the discipline of monastic life. Others have been vowed (sometimes before they were born) to the monastery by pious parents. Some sort of elementary education is given to the lads, and a few have a kind of mechanical training, but these are quite inadequate, and the industrial methods in the workshops are centuries old, Here the monastery which has great wealth and influence, ignores a splendid opportunity of usefulness. It might and ought to justify its existence by becoming a great centre of education, and by giving substantial benefit to the youths who in such numbers come temporarily under its influence. But the spirit of the Greek Church cloister is antagonistic to such enterprise, and Solovetsk neither fosters learning nor encourages proselytism.

The monks of Solovetsk are of plebian type, large and coarse of feature, and many of them—but not the officiating clergy—are quite illiterate. One very hairy hermit whom I had photographed, wished to have a copy of the picture sent him, but could not write his name. This is no exception, for the Solovetski brothers are mostly recruited from the peasantry, and sink into a life of stagnant indolence. But this is not true of all Russian monasteries, for they are often the refuge of the world weary, and open their gates to many a man who has drunk deep of the cup of experience; and as the higher offices in the Orthodox Church are only open to the Black Clergy, many ambitious men of good family



(15) Pilgrim Mujhik
(16) Monk
(17) Lay Brother
(18) Monk Dockmaster
(19) Monk
(20) Monk
(21) Pilgrim Nun
(22) Deacon
(23) Pilgrim Mujhik

SOLOVETSKI TYPES.

adopt monachism as a stepping stone to ecclesiastical advancement. But the Solovetski monks are merely drones who have withdrawn into monastic seclusion to seek a selfish salvation by prayer and penance. They lead an indolent existence, and when not engaged in the purposeless routine of their mechanical devotions, they gravely stroll about and lazily watch the lay brothers work. But the short summer when outdoor work is active, and the churches teem with worshippers, is succeeded by eight months of winter. Solovetsk is then indeed a hermitage, for over the lonely isles nature draws the curtain of the dayless arctic night, and round the distant shores builds the wide barrier of ice. The monks must then retire within their massive walls, and in pious isolation sleep and pray the cheerless winter through. At last when summer comes, and the night is but the night-long dawn of day, surely the most ascetic hermit must hail with glad welcome the first shipload of pilgrims from the great world beyond his narrow view.

A large proportion (nearly two-thirds) of the pilgrims are women. The sacrifices and penance of pilgrimage seem to have a greater attraction for women than men, and they travel long distances in groups of four or five to visit holy places. The younger generation travel by steamer or train, but the older ones prefer to walk for the same reason that many old presbyterians in our own country prefer to walk to Church. After a season of prayer, the God-worshippers return to the mainland and disperse toward their distant villages radiating and distributing throughout the land the fame of the far-off island cloister, and of miracles and cures by its saints.

There is a grievous contrast between the poverty of the peasant worshippers and the accumulated wealth of the cathedrals. For centuries costly gifts have been lavished on the shrines until in the light of the clustered tapers the golden ikons are all ablaze with many coloured jewels of great size and price, and the Sacristy is a store-house of rich treasures. But not even the poorest pilgrim comes empty handed, and although no charge is made for their entertainment, the monks afford the God-worshippers many opportunities to give donations. While the services are in progress, a pair of monks will wend their way among the pilgrims; one of them carrying on a short handle an offertory bag with bell attached, so that those who do not wish to see must hear it, and the other carrying a plate with money, to give change to any who cannot spare their smallest coin.

Throughout the day the mediæval cloister teems with reverent pilgrims wandering through the Churches doing homage at the altars, and gazing fervently upon the sacred relics of the saints; devoutly kissing the cases that contain them, and lifting the children that they may do the like. In the spacious covered corridors they stroll and loiter in groups, speaking only in subdued voices, without noise or laughter; feasting their awestruck eyes upon the mural pictures that show in lurid colours and shocking detail the tortures of the damned. In gruesomeness and crudeness of conception these coarse pictures are not a whit behind the Buddhists' illustrations of their hells. Sometimes a monk conducts a party, and from the Slavic characters of the inscription, reads to the wondering listeners of the terrors that await the unbeliever, for their salvation is by faith and not by works. Services are in almost continuous progress in one or other of the Churches from early morning until the evening, and when the great bells boom, or the little ones jingle, the pilgrims hurry hither or thither to obey the summons to prayers. All doors are open wide, and mingling with the deacons' sonorous tones come the noisy voices of the gabbling gulls that like tame poultry in the courtyard strut about the pilgrims' feet.

Besides the principal monastery there are many other shrines upon the islands hallowed by association with saintly men. And after morning prayers and the forenoon meal are over, the monks for a small charge convey the pilgrims by horse or sail to the holy places. One of the most interesting of these excursions is to the adjoining island of Ansersk, where on the summit of a wooded conical hill, "Golgotha," there stands a hermitage commanding an extensive view of the Holy Isles.

Ansersk was the retreat of the recluse Nikon who afterwards became one of the most famous of Russian Metropolitans, and who, by revising the prayer books caused a revolt in the Orthodox Church, and incidentally to a siege of Solovetski Monastery when the stubborn monks behind their fortress walls defied for ten years the soldiers of the Tzar. The outing to Ansersk includes an eight miles' drive, a four miles' sail and a six miles' drive, and return journey by the same route. On land the monkish charioteers drove like very Jehus, but afloat, when the wind failed, the sailor monks left the oars to the willing hands of tough-thewed pilgrim women. Even old women tugged the heavy oars with tireless energy, while the men lay idle, and the pilot monk steered.

Returning from Ansersk, one night, was a pilgrim woman with her son, a sickly man of about five and twenty years. He crouched in the bottom of the boat for shelter from the chilling wind, but was seized with violent ague-shivering. His nerve, shattered by long illness, failed and he wept pitiably, and between his spasms moaned for the shore. With trembling tenderness the mother tried to shield the sufferer from the keen night air, and with tear-filled, anxious eyes looked longingly on the still distant land. The characteristic kindliness of the Russian peasant was shown in the touching sympathy and genuine compassion of the other pilgrims, who, with their own clothing, warmly wrapped the shuddering man, and gathering to the oars, forced the sluggish boat to double its former pace.

The pleasure of driving through the pine woods was much marred by the number and ferocity of the large mosquitos that infest them, and seem to understand that in the short summer they must "make hay while the sun shines." At every break in the journey, chapels are at hand, which every pilgrim enters to pray. A foreigner who associates with these simple folk cannot fail to be impressed with their unassuming but cordial kindliness, for they seem to miss no opportunity of friendly attention and of making a stranger feel their companionship.

About a mile from the monastery is another favourite shrine; the hermitage of the monk, Filip, who attracted to Solovetsk the fickle favour of his former friend, Ivan, the Terrible. For a time the monarch lavished on the monastery rich gifts and grants of land, but later he summoned the reluctant Filip to the Primate's throne at Moscow. For years the one-time hermit restrained the turbulent Prince, but at last he suffered a martyr's death by his fierce master's order.

On the strand in front of the deep, dark arch of the Holy Gate, are two other shrines which receive much homage. These commemorate the landing of Peter the Great, for Solovetsk was twice visited by that meteoric Emperor. Go where you will in Russia you find the deep footprints of this most masterful man; this prodigy of energy and forceful enterprise, who drove the Swedes from the forests that skirt the shores of the cold White Sea, and pushed the Persians back along the arid slopes that bound the Caspian. The monks are very proud to have him on their roll of pilgrims, and in the archway of the entrance there hang two rude monk-made models of the ships he sailed.

Towards evening the droskys return with the pilgrims from the more distant shrines, and from the neighbouring ones the groups of God-worshippers wend their way, on foot, sedately back to the parent cloister. All are gathered at the refectory for supper, and in the long and restful evenings, when the last jingle of the bells that call to prayers had ceased, the pilgrims linger in the court-yards, with the trustful gulls, or stroll at leisure round the walls, or by the tideless shore. In the placid waters of the bay, the monastic buildings are mirrored with every outline of every dome and pinnacle, and every shade of colour, all warmed by the glow of the northern evening. Long-haired, black-cassocked monks walk gravely to and fro, with air of pious contemplation, as monks have walked before these walls for full five hundred years. As the hour grows late, no darkness falls, but by degrees the groups grow less, and the pilgrims seek the guest-house and repose, and the voices of the garrulous gulls are hushed. At last all sign of life has gone, and the great monastery, beneath its gilded spires, sleeps through the daylight night.

To a foreigner, fresh from the bustling streets of Western Europe, a sojourn in this remote retreat of monastic asceticism, is rich in instruction, and deep in interest. Here is a phase of a great nation's life. A phase the rest of Europe knew in mediæval times. The spirit of the middle ages pervades the cloister, and the atmosphere of rest and quiet meditation is at strange variance with the present temper of the Western world. But there is a singular charm in the tranquil environment of the convent life, and it appeals strongly to the Russian temperament; luring many a peasant who comes on pilgrimage to remain a voluntary exile, devoting his life and work to the famous sanctuary.

An Archimandrite of Solovetsk thus apostrophised his beloved hermitage. "Emerge out of your mists, oh wondrous habitation of the sea-girt land, Aurora Borealis of the North, flashing heavenwards the prayers, not of the White Sea shore alone, but of the most distant regions of unbounded Russia."

VII.—*History and Philosophy of the Factory System.*

BY

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AN old story tells how Sir Robert Peel astonished and puzzled the House of Commons during a discussion on Currency by proposing to its members this apparently elementary problem for solution—What is a *pound?* In a similar spirit I am inclined to commence my observations here to-night by inviting definitions from among my audience of the word *factory*. Many of you, I can well understand, will be prepared with one at once. A factory, they will say, is obviously a large building, or other place, where commodities are produced for sale in great quantity; and that is undoubtedly the popular meaning. Others might be more cautious; warned it may be by a futile endeavour to comprehend the law on the subject, or even a disagreeable experience of its operation. A few would I daresay remain who, having considered the subject fully, had come to the conclusion that it was very far from being as simple a thing as it seemed.

I am grieved to inform you that I who come before you in the guise of an instructor must be numbered with the last class. I have been officially conversant with factories for well over a quarter of a century, have studied their characteristics closely during that time, and written much about them, and yet I cannot for the life of me say, at this present hour and place, with any proper approach to certainty, what the technical, philosophical, or even legislative conception of a factory exactly is. Something of their history I can tell you, and a good deal about the regulation by the State of labour within them; and it may be hoped that in this survey some needed light will be thrown on the above mystery. Something too of the derivate meaning of the term. We will commence with that.

The term factory as formerly understood meant universally a trading establishment, usually in a distant country, with which were associated in idea the settlements and surroundings appertaining. It is primarily defined in this sense even yet in most dictionaries and works on industrial technology. After a while it came to be associated with the word *mill.* Dr. Aiken, in a *History of Manchester*, published in 1793, used these two words as equivalents, while Mr. Baines in *The History of the Cotton Manufacture* refers, as late as 1835, to its employment in its present sense as still a modern innovation. Ure's *Dictionary of Arts and Manufactures* does not possess any article on Factory; in Dod's *Dictionary of Manufacturers, etc.*, published in 1876, no allusion to an altered meaning is made, and even in the last edition (1880) of M'Culloch's *Commercial Dictionary*, it is merely described as an abbreviation of "manufactory." There is no help to be had here. How the curious connection, with the term *mill* came about, we shall see hereafter; what is important at present is to get rid absolutely of any association with the idea of trade.

Assuming the absence of this then, and accepting for the moment as satisfactory the ordinary conception of a factory as a place for producing commodities on a large scale, it will presently become evident that a very high antiquity must be claimed for such like. It is not merely that they are as old as history, but far older, unmistakable traces of them being found in that vast, silent time ere history was. Sir Charles Lyell was I think the first writer of distinction to draw attention to the existence of such places during the Neolithic age, by a description in his well known work on "The Antiquity of Man" of one near Bern, in Switzerland; and since then many have been discovered elsewhere, in France, Belgium, Germany, America, and largely in the British Isles, among other places. A still more recent discovery in Poland seems to point to the existence of a factory of *Palæolithic* implements, though this needs confirmation. My audience will possibly excuse me if I do not attempt to describe the factory system of this period, one which may range any time between ten thousand and a few hundred thousand years ago. That investigation belongs rather to another branch of this Society, to whose attention I have now much pleasure in commending it. Subsequent to, or perhaps in some instances contemporary still with, it we have abundant proofs of a system of organised factory labour under the great archaic civilisation of the East and of Northern

Africa. In ancient Egypt, for example, pictures indelibly graven on the monuments and retaining almost their original freshness furnish full particulars of the scene. Gangs of workman are employed under a taskmaster or overseer, different sections of the labourers being engaged in different branches of the work, and all co-operating towards a common end. In the manufacture of bricks, for instance, in which you will remember the captive Hebrews took so conspicuous a part, this is presented with great clearness; and also in that of pottery, leather, and some others. It is a source of lasting regret that no similarly clear presentation of the great textile industries has been found, and especially of that of linen, for some thousands of years the staple manufacture of the country. Yet that the factory system was operative in this direction too must seem clear if only from the circumstances of that great production. How else could the vast quantities of linen yarn which we know to have been used, not only by the native population, but for export, have been produced? Nor are we without some indications of it, though faint ones. In the tombs at Beni Hassan, women, apparently captives, for their legs are tied, are shown spinning in company, and elsewhere both men and women weaving; while in one instance, both these processes, with several appertaining are figured taking place together. Moreover certain modern writers, particularly well qualified to judge, have not scrupled, both to affirm this fact, and even, in some cases, to actually describe and locate the process. Mr. James in *The History of the Worsted Manufacture* writes as to weaving:—"The Egyptians resembled ourselves in this, that they possessed large weaving establishments, and supplied with their products foreign lands," whilst Mr. Warden, a Scotchman and author of *The Linen Trade Ancient and Modern*, is not only of the same opinion, but pictures the places of work as "of a kindred nature to the hand loom weaving shops not yet extinct in this country." Lastly, M. Maspéro, most learned of recent Egyptologists, in describing the imaginary aspect of that country during the reign of Rameses II. (*i.e.*, about 1400 B.C.), offers the following direct and detailed testimony as to spinning. "Apu," he writes, "is celebrated for its spinning mills;" adding in a note, "The spinning mills of Apu *still exist;* their chief manufacture is a material with little blue and white checks, of which the fellah women make their outer garments." In Babylonia and Assyria, where the cotton and woollen, rather than the linen manufacture flourished, there were large factories. Bonomi attributes their origin to Semiramis, who, he writes, "founded great weaving establishments along the banks of the Tigris and Euphrates." This ascription, of course, is only useful as showing their vast antiquity. Of the great glass factories and dye-houses of ancient Phœnicia we have no record; though it is evident they must have been on a very large scale; nor of the vast industrial establishments of old Carthage. Passing to classical times, we find that during the later days of Greek supremacy the factory system had spread greatly. Megara and Miletus were famed for their production of coarse woollen cloths; Athens itself principally for cutlery and armour. The father of Demosthenes employed a large number of workmen in this latter industry, and realised a handsome fortune from it; the celebrated banker Pasion was likewise engaged in it. On one occasion he presented the Government with a thousand shields made in his workshops. In ancient Italy, as we are definitely informed by the eminent French economist Blanqui, it had a wide development. "Rome," he says, speaking of the early years of the empire, "was full of manufactories." This was, of course, subsequent to that more patriarchal age when the industries were principally domestic, as in their infancy they ever are. On the conquest of Britain the Romans established the factory system here. At Winchester they had a very large textile factory, where material for clothing the army of occupation was produced; at Gloucester, Bath, and elsewhere, smelting furnaces and iron works on a great scale; extensive potteries in many places.

Now what were the characteristics of these factories and of those who worked in them? To what extent did their system of labour resemble or differ from the system of to-day? In the first place it was in the vast majority of instances servile labour that was employed; in the second place, the processes of manufacture were all or nearly all manual. A few instances to the contrary of this latter characteristic amongst places that have been recently classed as factories might be found, and some allowance must be made for the part played by organised trade societies in ancient times, a branch of archaic sociology which has been strangely neglected. Several centuries before the Romans invaded Britain, corn mills driven by water power were brought into use by them, and Antipater (who was a contemporary of Cicero) alludes thus gracefully to the relief thereby afforded to workers especially women, who usually operated the smaller kinds. "Cease your work," he writes, "ye maids who laboured at the mills; sleep and let the birds sing to the returning dawn for Demeter has bidden the water nymphs to do your tasks. Obedient to her call they throw themselves on the wheel and turn the axle and the heavy mill." But, as has been indicated, such instances of employing a foreign motive power were rare. It was then principally manual labour wrought by slaves. Now nothing is more remarkable among recent antiquarian discoveries than the elaborate legislation affecting slave labour that has been brought to light. The engraved tablets of ancient Chaldea and Assyria are ever yielding fuller store of information on this curious subject, which should be compared with later developments contained in the better known codes of Classical jurisprudence, of Hebrew economy, and of the communal systems of various countries. The status of the worker is in all these cases clearly defined. Their system resembled ours then in the employment of aggregated labour for production on the large scale, but differed from it in respect of its social and mechanical agents.

When the Romans left Britain, their great manufactories passed away with them, and for eight or nine hundred years there were no factories. Production was on a small scale, and for use, not trade. Gradually with the advent of increasing power and prosperity they began to appear again, and to show some premonition after a while of the new type. In 1313 we have certain information of "A mill for the dyers on the bank of the Irk" near Manchester, and in 1322 of a fulling mill turned by the same river. But already six years earlier than the latter date (that is in 1316), information reaches us (through Mr. James' *History of the Worsted Manufacture*) how in that year "large quantities of cloth were fulled" in a mill near Bradford. We are now on the track of that singular connection between the terms *mill* and *factory* of which mention has been made. The proper purpose of a mill is of course *grinding*. Now fulling, which is pounding or macerating cloth, has a sufficiently near resemblance to the other operation to be possibly confounded with it, and is in fact sometimes called *milling*, presumedly on that account. Presently the epithet began to include processes more remote. In 1551 complaint is made to Parliament of the establishment of "gigge mills" contrivances, that is for raising a *pile* or *nap* on cloth; a process therefore wherein little trace of the original meaning of the word remains; and at length *winding*, *spinning*, and a variety of operations dealing with the treatment of fibrous material are found spoken of as performed in mills—operations wherein the original technical signification is altogether lost. Its close connection with the term factory now begins. When the novel edifice which came to be known by that name first arose among us the corn mill and fulling mill were the nearest analogues both in popular experience and actual location, and thus the purpose as well as appearance of these got mingled. But further, spinning factories were often put up in the neighbourhood of fulling mills for convenience sake, and corn mills converted into them, the building still retaining its name in spite of the change of manufacture.

This more general application of exterior motive power brings us to the development of the modern factory system, but a few words remain to be said as to earlier English factories before passing on. For there were factories in England, and on a great scale too, before the modern factory system settled there. Such a one, for example, was Jack of Newbury's in Berkshire, employing over a thousand persons, and which flourished in the reign of Henry VII., and similar ones were to be found then or somewhat later at Kendal, Halifax, Bristol, Norwich, and elsewhere. They differed from the factories of antiquity by employing free labour—though it was not quite free either, the masters of those days taking a more patriarchal view of their duties to their workpeople than is popular or permitted now. And they differed further from typical factories of the modern, and resembled those of the ancient kind by employing little or no exterior motive power. A few manufacturing processes, as we have seen, were beginning to be performed in that way, but the bulk of the work was manual, even as the bulk of the work is now performed by power, but a residue still by hand. In a metrical romance of the 16th century by one Thomas Delony, there is a very vivid description of the internal economy of "Jack of Newbury's" factory, an employer whose real name was John Winchcombe or Whitcombe. It is too lengthy to quote, but a few particulars will be of interest. Some of our amateur factory reformers may derive useful hints from it perhaps in view of further contemplated legislation. This establishment had no less than 200 hand-looms at work in a single room; which we are assured accordingly was "large and long." Each loom was served by a man and a boy. One hundred women carders are mentioned, who are represented as "singing merrily" at their work—not only "with joyful cheer," as is gratifying, but "voices clear," which it must be allowed is not always a characteristic of the female operative. There seem also to have been 200 spinners—conceivably no less musical; 150 children picking wool, 50 shearers, 80 "rowers" (whatever that was), 40 dyers, and 20 fullers, in all, as I have said, about 1000 persons.

But the provision that was made for these workers is still more remarkable, and compares advantageously I think with even the most modern of legislative programmes:—

"Each week ten good fat oxen he
Spent in his house for certainty;
Besides good butter, cheese, and fish,
And many other wholesome dish.

He kept a butcher all the year,
A brewer eke for ale and beer,
A baker for to bake his bread,
Which stood his household in good stead.

Five cooks within his kitchen great
Were all the year to dress his meat;
Six scullion boys into their hands
To make clean dishes, pots, and pans.
Besides poor children that did stay
To turn the broaches every day."

We do not quite see what part would be left for our Factory Acts to play in an establishment of this festive description!

The first factory in England of the modern type was commenced building at Derby in 1715, and at work two or three years afterwards. It was a factory for "throwing" or winding raw silk, copied from others of a like kind already existent in Italy. The story of its origin and establishment is most romantic and extraordinary. I regret that time will not allow me to tell it. It was soon succeeded by others similar, and their success set ingenious minds at work considering if the same system could not be applied to other fibres. I must explain that raw silk is not *spun*, but comes in a long filament from the body of the worm. Could anything like this silk filament be produced by machinery moved by mechanical power and dealt with afterwards as the silk was? That was the problem. It had of course from time immemorial been produced by hand power, and of almost equal fineness and beauty, but could the operation of twisting it through the fingers be imitated to the extent and in the manner required? It could. It was. By a series of incomparable inventions this amazing feat was performed, to be presently succeeded by another, only a little less extraordinary. So much yarn was thus spun that there were not weavers enough to weave it. Could not the weaving be done then by machinery too? A country clergyman casually seated in an inn and hearing the question, answered it in the affirmative. Cartwright was the inventor of the power-loom, as Paul, Wyatt Arkwright, Hargreaves, Kay, and Highs were the authors among them of spinning machinery. It wanted one thing yet to crown the edifice, namely that the motive power to set all these appliances in motion should be of an absolutely reliable kind, dependent not on wind or weather or other chance or change of season. That final requirement was supplied by the genius of your great fellow-townsman, Watt. He took up the steam engine when little better than a toy, and applied it to the vastest purposes of industrial production.

Here then we have at last the perfected factory of the modern kind. Within an establishment of definite bounds a series of free labourers are cooperating in a productive process, the motive powers being furnished from without. That is the distinctive type. Up to the present I have spoken of the new methods mostly in connection with textile fabrics, but that is a mere accident of the exceptionally prominent part played by this manufacture in the development of the modern factory system. They are equally applicable, as we know, to others. Both steam and water power were in use in metal at least as early as in textile industry, indeed, it has been said that it was whilst watching the process of rolling metal wire at one of the great Birmingham foundries that the possibility of spinning yarn by machinery was first suggested to the fertile minds of Paul and Wyatt. We shall presently have to note a similar prominence with relation to the development of factory legislation, to an extent that even in the minds of legislators the two series of events came to be confounded. That was, and is, of course a great error, and may at once be stigmatised as such. I have little doubt, I have indeed no doubt at all (speaking individually) that if none of those great mechanical inventions had ever occurred which did occur we should by this time have had nevertheless some such a code of laws affecting labour as our present factory laws. It is possible to argue even that the particular march of events which has produced them in their present form has acted detrimentally as a whole, in postponing their completion and diverting attention from their true sanctions. The modern factory system forms but an episode, not an epoch, in the great industrial revolution whose chief characteristics are the abandonment of status for contract, of custom for competition, and of manual for machine labour. It was preceded by others, as we have seen; will be followed by others we may be sure.

The exact sequence of events was as follows. The first factories in the modern sense were water mills, often of necessity situated in remote places, situated in fact in the most likely places for obtaining full advantage from that source of power. A great many were cotton mills, the cotton manufacture being just then extremely prosperous. In these the newly invented machinery was set up, generally in feverish haste. It consisted of appliances, clumsy beyond measure when compared with those of to-day, but many of whose movements nevertheless were fine and delicate, such movements as the nimble fingers of children were specially well calculated to deal with. The machines moreover were commonly crowded together within unsuitable buildings in those early days, and full-grown people had a difficulty in working at them. Thus it came about that juvenile labour was in especial request, and a practice grew up of importing it from a distance and binding the young people apprentices for a term of years. A detestable condition of things ensued. Removed from the constraint of publicity and the protection of the ordinary law, these helpless little ones were often treated with shocking inhumanity, and the commonest requirements of health and decency neglected. The truth began to be whispered about, obscurely at first, but with increasing emphasis. It was said that the new factories were not only dens of infamy but hot beds of disease; and then people began to be alarmed. An agitation was commenced in Manchester to have some remedial measures applied lest an epidemic should break out and spread over the country. At this time the first Sir Robert Peel was a member of the House of Commons and also a very large employer of labour. In 1802 he introduced a Bill into Parliament, the preamble of which runs as follows:—"Whereas it hath of late become a practice in cotton and woollen mills, and in cotton and woollen factories, to employ a great number of male and female apprentices, and other persons, in the same building, in consequence of which certain regulations are become necessary to preserve the health and morals of such apprentices; be it therefore enacted," etc. This Bill became law under the title of "The Factory Health and Morals Act." It was the first of a long series which has since adorned the Statute Book, and the end of which is not yet. It was obviously inadequate in two directions, even for the limited purpose which it had in view. First, children not being apprentices were left unprotected; second, it applied only to cotton and woollen manufacture. In 1815 Sir Robert Peel brought these matters up for remedy in an amending measure. He proposed that no child under the age of ten years should be employed either as apprentice or otherwise in *any* factory; but in the following year limited the recommendation to cotton mills alone. The whole matter was thereupon remitted to a Committee of Enquiry—and from that time intermittently to the present, has, in continually expanding circles, never ceased to be a subject of controversy. Why cotton factories only? Why any kind of factory more than another? Why factories at all more than other work places? Why young people especially? Nay why not—for the same reasons—every enterprise in which the same relation of employer and employed exists?

This is the question of the proper sanction for any form of factory legislation. Herein the philosophy of the factory system and of factory legislation meet. It is a question that has not been answered yet, but it will have to be answered some day. What's more, it presses for an answer. It will not be shirked or thrust aside as something insignificant and unreal. It is neither of these things. A little expanded we may put it thus:—In every labour system of which we have any knowledge throughout the history of mankind there had been up till recently some recognised protection for the worker. Under ancient forms of slavery, as we have seen. Under any form of serfdom, as we know. Of the very essence of the institution of Caste. Under the Patriarchal, Communal, and Feudal systems. Why not? Is not the worker—of every kind—quite obviously the most valuable member of the community economically considered? Is he any less considered ethically? The proposition has but to be stated in this its simplest form to meet with general acceptance. At the commencement of the modern factory system, however, there was practically none. The mediæval Guilds which had till recently afforded some, had completely broken down, the obligations of feudality had passed away, the immemorial customs of communal possession survived only in name. In their places a system of political economy was prevalent that denied any necessary relation existing between employer and employed excepting only through the wage-bond; the "cash nexus" of Carlyle; while any interference with this same was treason and heresy. Meanwhile productive industry was stimulated beyond all precedent, manifesting itself in novel forms and among hitherto undreamt of surroundings. We have already seen to some extent what followed. The well meant efforts of the elder Sir Robert Peel proved futile, partly owing to the opposition they encountered, partly to his own half-heartedness in following up his first success. Vainly did that much misjudged man Robert Owen (who has made the beautiful upper waters of your Clyde so memorable) strive to egg him on to further efforts; in vain a few other public spirited men take up the cause; it was not until the emergence of Richard Oastler of Sadler, and at length of the noble-hearted Lord Ashley on the scene, that definite progress was made. The combined efforts of these reformers, and of some others, aided by the revelations of a series of public enquiries which had now been held, eventuated in the passing of the Factory Act, 1833, which is one of the landmarks of factory legislation. This statute which still dealt exclusively with textile manufacture conducted by exterior motive power, and applied only to juvenile labour, was a carefully considered measure. It was systematically violated however, nor was it until the passing of the Act of 1844, further strengthened by the rapidly succeeding ones of 1847 and 1850, that the administration of the important code of laws that had by this time been evolved was put upon anything like a secure basis.

The half century thus covered—roughly speaking between 1800 and 1850—is what may be called the classical period of the modern factory system. Within it the typical edifice which still furnished to most minds their only conception of a factory attained that sudden and portentous growth which doubled and quadrupled great city populations and changed country villages into busy towns. Within it some of our fairest landscapes perished, to give place to grimy wastes and seething centres of industry. During it the great Factory Controversy reached its zenith, and legislation on this head was a question which made and unmade Ministries. It includes the agitation for a Ten Hours Bill, practically conceded by the Act of 1847. It includes the rapid rise of machine industry. It includes also most of the few literary efforts which touched with fancy this rather uncongenial theme. Chief amongst them is Mrs. Browning's beautiful poem "The Cry of the Children," with which most of you are no doubt familiar, but with which some of you perhaps may not be, for it is little read I fear now. I venture to quote a couple of stanzas for any who are in this latter evil case. It is to be remembered that when it was written the Factory Controversy was still in that stage when protection was demanded only for the young, and even this modest requirement too often met by a storm of disapproval which it is difficult to realise now. Mrs. Browning writes:—

"Do ye hear the children weeping, O my brothers,
Ere the sorrow comes with years?
They are leaning their young heads against their mothers,
And *that* cannot stop their tears.
The young lambs are bleating in the meadows,
The young birds are chirping in the nest,
The young fawns are playing with the shadows,
The young flowers are blowing towards the west—
But the young, young children, O my brothers,
They are weeping bitterly!
They are weeping in the playtime of the others,
In the country of the free."

"Do you question the young children in the sorrow,
Why their tears are falling so?"
The old man may weep for his to-morrow
Which is lost in Long Ago;
The old tree is leafless in the forest,
The old year is ending in the frost,
The old wound, if stricken, is the sorest,
The old hope is hardest to be lost—
But the young, young children, O my brothers,
Do you ask them why they stand
Weeping sore before the bosoms of their mothers
In our happy fatherland?"

. . . .

"For oh, say the children, we are weary,
And we cannot run or leap;
If we cared for any meadows it were merely
To drop down in them and sleep.
Our knees tremble sorely in the stooping,
We fall upon our faces trying to go;
And, underneath our heavy eyelids drooping,
The reddest flower would look as pale as snow.
For all day we drag our burden tiring,
Through the coal-dark underground,
Or all day we drive the wheels of iron
In the factory round and round."

Such pleading was not in vain: the "young, young children" were the first cared for, and the child age which was then eight has since been raised by successive stages to nine, to ten, eleven, and twelve years, while the period of labour has been reduced from nine to six-and-a-half hours per day.

By the Factory Act of 1844 the industry of women in factories was brought for the first time under the protection of the State. It had already been legislated for in mines. But a factory was still conceived of as a place where only textile manufacture was carried on, and the efforts of factory reformers during the next quarter of a century were directed rather towards expanding this conception than considering the new problems which the protection of adult labour had thrust upon them. Three classes were formed, of women, young persons, and children who were the subjects of legislation; the labour of adult men was excluded. But women, children, and young persons worked in other places than textile factories. Under what conditions? With a view to discovering this, two great Commissions were now successively constituted to go about the country taking evidence and to report the result to Parliament. These important bodies, rather inadequately named the first and second Children's Employment Commissions, have had through their Reports a mighty influence on the social destinies of this nation. Carefully constituted, and laborious almost to a fault in the taking and sifting of evidence, they utterly pulverised the old idea of industrial evils appertaining only to a single type of work-place. They proved, upon the contrary, that they were practically conterminous with the whole scope and field of modern productive industry. True, there might be exceptional drawbacks connected with the early cotton and other mills while the practice of apprenticeship prevailed, and they were situated mostly on remote mountain streams. But that time was over. Steam had succeeded water power as a motor, factories were built now wherever the greatest supply of labour could be obtained, and apprenticeship was therefore no longer needed. Yet in those other places, and under quite different conditions, the same necessity was found existing, the necessity namely, of opposing some obstacle to the unlimited greed of competition. Accordingly a series of enactments ensued, bringing first one industry then another more or less cognate with textile industries—as bleaching, dyeing, etc.—under supervision, then a large number in no way connected with these. The word had now been spoken, the floodgates were open wide, and the natural consequence ensued. Into the legal receptacle thus provided presently poured a whole host of other occupations clamouring for protection on the same ground, and receiving it on the same plea, till at length under the provisions of the Factory Extension Act (1867) this long suffering term came to mean no less than from thirty to forty different things, some named specifically, others inferentially, others having no more claim to a specific type than the mere number of persons employed. In this Factory Act a "factory" is defined, among other things, to mean—"Any premises, whether joining or separate, in the same occupation, situate in the same city, town, parish, or place, and constituting one trade establishment, in, on, or within the precincts of which fifty or more persons are, or have been during the preceding year, employed in any manufacturing process."

My audience will by this time have some inkling of what I meant in an earlier part of these remarks by inviting a definition of the word "factory" from among them. Already we have arrived at some forty or so; and there are more to come. Is there then no philosophical finality to this term; has it no specific place in technology? It was probably some such considerations as these which induced the legislator in this same year (1867) to attempt a new departure and devise another category in which work-places even still unincluded might be placed. The result was the passing of The Workshop Regulation Act. Under this statute "workshop" meant nominally every industrial establishment, not a factory, in which less than fifty persons were employed. Such a distinction was manifestly absurd; for how did the dismissing or taking on of a single worker differentiate in any way the process of the industry or the need for its protection? Moreover, the enforcing of this Act was committed at first to Local Authorities, and many of these omitted or failed to enforce it. The position quickly became intolerable; within four years its enforcement was transferred to the Factory Department, and in seven more an attempt was made to consolidate the whole body of laws into one enactment. The resulting statute The Factory and Workshop Act, 1878, is that which, with some additions, is still in force. In this one the criterion of numbers is entirely given up and an attempt made to distinguish between factories and workshops on the basis of whether mechanical moving power is in use in them or not. This attempt is again a failure. Several places are specifically excluded from its own definition, while to others its application is ludicrously illogical. What does it matter either to an overworked operative whether some of his work is performed by machinery or otherwise? But further, a large sphere of work of the severest industrial kind had been designedly omitted, and the public—little read in the subject—wanted to know why. In this sphere the personage to whom the unsavoury name "Sweater" has been given reigns supreme, but it was in fact the male adult who was coming to the front at length. A "Sweater" it appears—it *appears* I say for the appellation still remains indefinite—is a sub-contractor, one to whom work is given out by another employer, and who becomes responsible for it and for the care of those who do it. Upon this official—a common enough one nevertheless in every branch of trade, commerce, and in the ordinary affairs of life—an astonishing amount of abuse was for a while discharged. He was the industrial scapegoat, the "bogie man" of the moment, and it was demanded that Factory Legislation should be extended so as to include him. Such was the principal object of the Act of 1891. But there were others. A reverse tendency to specialise certain industries now appeared, and has been in progress ever since. Finally came the Factory Act, 1895, in which not only was this tendency emphasised, but new developments occurred. The hard work laws were extended to the business of transport; to buildings in course of construction; to warehouses, laundries, and at length, any building which exceeds thirty feet in height and in which "more than twenty persons not being domestic servants are employed for wages." *O tempora! O mores!* with what astonishment would the early patriarchs of the Factory Controversy regard such results as these!

But, what *is* the sanction of this great and continuous extension of government interference with industry; to what extent and in what degree is it feasible and desirable; and what have been its results so far? With a few observations on these heads I propose to conclude. The sanctions clearly are both ethical and economical. In this place we will assume the former; our immediate concern is with the latter. Now I take it that one of the fundamental doctrines of modern economics proclaims the advantage of free contract in an open market, and that an accepted division of the agents of production resolves them into the three categories of Land, Labour, and Capital. But to what extent can there be free competition in an open market between capital and labour without the occurrence of something to harmonise their relations? What sort of freedom has a man who must either undertake a certain task or starve? Politically free he may be; free as air; but economically unfree. The industrial merits of this open competition are unequal, and the economic result must take shape accordingly. It is here that factory legislation comes in. There are certain compelling forces, it says, which must be modified. You must not take advantage of the "higgling of the market" to its full extent when dealing with your fellow citizen. It is not only that you will degrade him in doing so—that has to do with the ethical sanction,—but deteroriate his labour likewise. This latter is an economical loss just as certainly as it is a most villainous act. And dimly throughout the long history that I have put before you you will have seen this principle emerging, now grasped for a moment and then perhaps let slip, now blindly followed, now almost lost, while ever, whether consciously or not, reached-out-towards, striven for in the main. The slave-owner will treat his slave no better than an animal perhaps, but then he will treat him at least as well; he will feed, clothe, lodge, and protect him from others; it is his clear interest to do so. He will even be usually a party to some legislation on his behalf, such legislation as the great slave-holding countries of the ancient world were familiar with, as were in operation on British and American plantations until recently. At the worst there will be some such law as our Cruelty to Animals Act, for instance. The chieftain or patriarch is personally concerned about his child or clansman; he will not leave him to shift for himself when in a difficulty. In a commune or caste the status of every member is assigned; and failing these protective influences a similar result may be obtained by custom or by organisation, provided political conditions allow. In this country as we know they have been so obtained, certain picked industries having even secured a shorter work-day for themselves than is claimed by legislation. These organisations are, however, composed exclusively of men, and number altogether only one-eighth or one-ninth of the whole employed population. What is to become of the remaining eight-tenth or nine-tenth? Combine also you may say. But what if their social and other conditions are of such a kind as to prevent them? Are they to be therefore left to perish? Again, it is possible to conceive of an industrial State so admirably organised that factory legislation would have no room there. Such was apparently the condition of Peru when it first became known to

Europeans; such is the ideal Socialistic State. Well, when that time comes we shall do without it. Possibly we are moving towards such an organisation of society now; possibly we are not. But anyhow, and in the interim, let us cleave to what we have.

As to the due limits to be set to these laws that is a problem in process of evolution by experience, as we have seen. If the history of factory legislation teaches us anything with unequivocal distinctness it is the extremely tentative and empirical basis on which it has been raised. Herein resides the excuse for the extraordinary perversions to which the title has been subjected which early formed a ground of lamentation for us. To what extent, for example, the industry of adult women should be protected more than of men is a matter that is full of difficulty. Partly by the customs of society, partly by the direct action of men, and partly on account of physical disabilities, the labour market is narrowed against them. It results that the "sifting" of that market must in their case be always a sifting downwards, and that they would be condemned again, as formerly, to the most destructive toil did not some other power intervene. Again, as to the point at which Government interference with labour becomes too minute, too inquisitorial. It is a constant source of astonishment to some of us nurtured on the old *laissez faire* doctrines how far it has already gone, but this is nothing, I believe, to what is in contemplation. I thought the boundary was pretty nearly crossed when a Factory Act was demanded for domestic service, but, if I understand some of our lady novelists rightly, there is a call for something of the kind in domestic life itself! Take again the ever popular demand for shorter hours of work. There must be a limit somewhere even to the beneficial effects of this reform. If it be true, as it appears to be, that the efficiency of labour is not always to be measured by the time over which it extends—as Karl Marx among others seemed to think,—that longer hours do not necessarily produce more output, yet there must be a period even to that progression. If it be a fact that as much work can be done in 8 hours as 10 hours, still the same rule can hardly be expected to apply to 6 hours, to 4 hours, and in ultimate analysis to no hours at all! Somewhere or other an equilibrium between man's capacity for work and the work to be done undoubtedly exists. It is highly important no doubt that he should not overstep that limit in respect of those capacities, but it is also of some consequence surely that he should not forego his proper privilege of attaining to it and so transfer his sources of livelihood to another. A problem of great difficulty is the judicious regulation of home industries. These are often carried on under most unsuitable conditions, and always under conditions which compete to the disadvantage of organised industries. On the other hand they not unseldom furnish the only possible means of honourable existence to an extremely destitute and pitiable class. To what extent should they be supervised or checked? I do not believe they should be checked. Supervised they undoubtedly should be, as should every kind of labour that is unable to effectually defend itself, but here more than anywhere else in the whole wide round of industry should factory laws (so-called) be applied—in my estimation—with caution, with reserve, with almost tender care.

What is the general result, finally, of the great growth of the factory system among us during the last one or two hundred years? Upon this point it is considered enough by some to refer to the advances the country has made in material prosperity within that time. I am not, however, of that opinion. I am aware that many other influences have been at work in producing this result, though I am far from denying that it has been a principal one. Moreover, I doubt if material prosperity is, after all, the greatest blessing which a country can possess. And I do not shut my eyes to the other side of the account: the huge concentration of labour on industrial centres, which is one of the portentous features of our time; the devastation of some of our most beautiful landscapes; the pollution of our rivers and our atmosphere; the increasingly important position assigned to capital in production; the supersession of the craftsman, and divorce of industrial faculty from workmanship. Many of these are but indirect results no doubt, but so, I believe, are some of the most genuine advantages that it has brought to us. It is to the factory system that we proximately owe much of our modern enthusiasm for sanitation, to it we directly owe the first efforts towards national compulsory education; equally to its operation, though still more indirectly, that growing concern for the lives and limbs of workers the necessity for which it first brought conclusively home to our lagging apprehensions. These gifts of the factory system are the proper glory of factory legislation, which I number among its results. True I have said elsewhere that the particular course which this pursued with us was perhaps unfortunate, and it was certainly undiscerning, that it developed in a haphazard and empiric way, that had we had no modern factory system some such code of laws would have had to be evolved. Still it *did* procure them for us, they are with us now, will not easily be parted from, are gradually spreading into every nook and cranny of our otherwise callous system of competitive industry. We can forgive the tortuous paths they have taken, we can excuse even the astonishing perversions of the distinctive term, and accept the great material benefits of the factory system with a clear conscience, in view, but only in view, of the compulsory restrictions thus placed upon it.

VIII.—*The Late George A. Turner, M.D.*

BY

ROBERT FULLERTON, M.D.,
Hon. Secretary of the Geographical and Ethnological Section.

[Read before the Society, 7th March, 1900.]

IT is fitting that the work and worth of those who during life bore their share of the burden should be noted when they have passed away, and this perhaps in a special degree is called for in the case of Dr. Geo. A. Turner.

By his death on the 26th January, at the comparatively early age of 54 years, the Philosophical Society of Glasgow was deprived of a valuable and highly-esteemed member, and the blank caused by the loss of his genial presence and wise counsel will long be felt.

He was born at Malua, Samoa, on the 30th Oct., 1845, where his father the late George Turner, LL.D., one of the earliest missionaries in the Pacific, was stationed under the London Missionary Society.

He was sent home when eight years old, and educated at the High School of Glasgow, and at the Glasgow University, graduating M.B. and C.M. in 1867 and M.D. in 1870. He was a distinguished student, and it is interesting to note that when studying medicine, he acted as a dresser with Lord Lister who at that time as Surgeon to the Royal Infirmary was developing his antiseptic surgery. In 1867 he also passed through the United Presbyterian Theological Hall in Edinburgh, and shortly afterwards was ordained a minister in the Kent Road U. P. Church in this city.

Eager to take up work, he returned to Samoa as a Medical Missionary early in the following spring, where, for nearly 12 years he laboured under the auspices of the London Missionary Society.

The unsatisfactory state of Mrs. Turner's health necessitated a return to this country in 1880, and after being home for nearly a year, during which time he was largely occupied with deputations in connection with the London Missionary Society it was finally decided to settle in Glasgow.

Accordingly he started medical practise in 1881 and rapidly attained an excellent professional position.

Dr. Turner's connection with the Philosophical Society began shortly afterwards, for he was elected a member and appointed Honorary Secretary and Treasurer of the Geographical and Ethnological Section in 1883, and the following year was elected a member of Council. In 1894, he became President of that Section, and it was with regret that at the beginning of the present session his resignation of this office was accepted on the plea of failing health. During the whole period of his connection with the Society he often took part in the discussions, showed a deep interest in its general working, and in 1883 contributed a paper which appears in the *Proceedings* for that year, entitled:—" On the Verification of Traditions regarding the First Peopling of Certain Islands in the South Pacific."

As a physician he more particularly devoted himself to Obstetrical and Gynæcological work. He was a member of the Medio-Chirurgicial Society; Secretary, and afterwards President of the Obstetrical and Gynæcological Society: Dispensary Physician for Diseases of Women, Western Infirmary; and a Governor of Anderson's College.

Besides other papers and addresses attention may be drawn to some fruits of his unique experience of Medical and Surgical practise in the South Seas. These are largely embodied in his article on Elephantiasis in Anderson's Treatise on Diseases of the Skin, and in a paper entitled:—"138 Cases of Amputation of the Scrotum for Elephantiasis Arabum," which appeared in the Glasgow Medical Journal for 1882. From an examination of the photographs in connection with this paper it is difficult to realise that such operations could have been successfully undertaken with only the assistance of natives which he himself had trained.

His natural tastes fostered by a long residence abroad led him to take a deep concern in all that related to Geography, and when the Royal Scottish Geographical Society was founded 16 years ago, Dr. Turner took a leading part in the formation of the Glasgow Branch, the Honorary Secretary of which he continued till the date of his death. To the Magazine of this Society he contributed an article on "Samoa" in 1889.

His intimate knowledge of the Samoan language and customs gave him special influence with the natives, and this influence enabled him on more than one occasion to render valuable service to the representatives of H. M. Government during periods of political disturbance.

He maintained throughout life a strong love for his former home, and expressed regret when this country relinquished her claim on the islands in favour of Germany.

From what has been said it will be seen that his life was full and unselfish, but apart from those interests which have been noted, he took little part in social or public affairs, rather seeking relaxation and pleasure in his domestic circle.

He never felt quite the same since he had an attack of influenza six or seven years ago, and an illness towards the end of 1898 made him feel still more the necessity of husbanding his strength.

Honourable, upright, and free from any trace of bitterness, he displayed the true Christian spirit with an influence essentially for good. Those who knew him will long cherish his memory, and the recollection will make us feel better and stronger.

IX.—*On the Relation of the Ash to the Height of Plants.*

PART I.

BY EDMUND J. MILLS, D.Sc., F.R.S.; and
JOHN IMRIE, A.I.C.

[Read before the Society, 7th March, 1900.]

THE researches of Wolff Arendt, Norton, and others have shown that the amount and nature of the ash of plants may vary from part to part of their structure; indeed, the multifarious demands of such parts could hardly lead to any other result. Our investigation had for its object the ascertainment of the quantity of

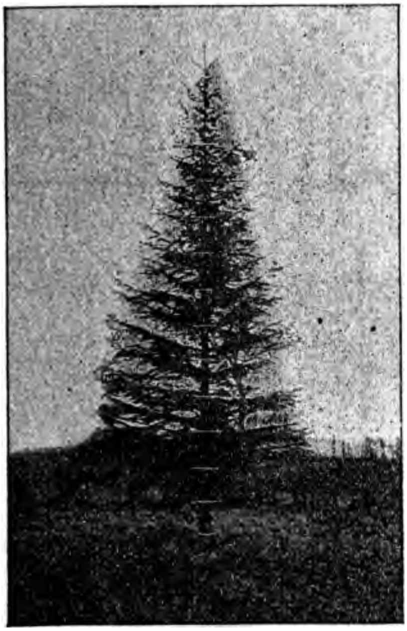

Fig. I.

silica and ash in sections of equal altitude ($19\frac{3}{8}$ inches) taken from a healthy tree (Spruce Fir).

The tree (Fig. I.) was very kindly placed at our disposal by Dr. David Wilson, of Carbeth, Killearn, under whose immediate superintendence the sections were made and forwarded to us. Cutting down took place in the month of December.

It will be understood that each section, with the exception of No. 1, which is nearest the ground, comprised branches and leaves, as well as the portion of the bole and bark to which they belonged; the sections were taken through the bole only. The bags containing the sections were stored in a room for many months, when it was presumed that they were in a condition for weighing and subsequent treatment.

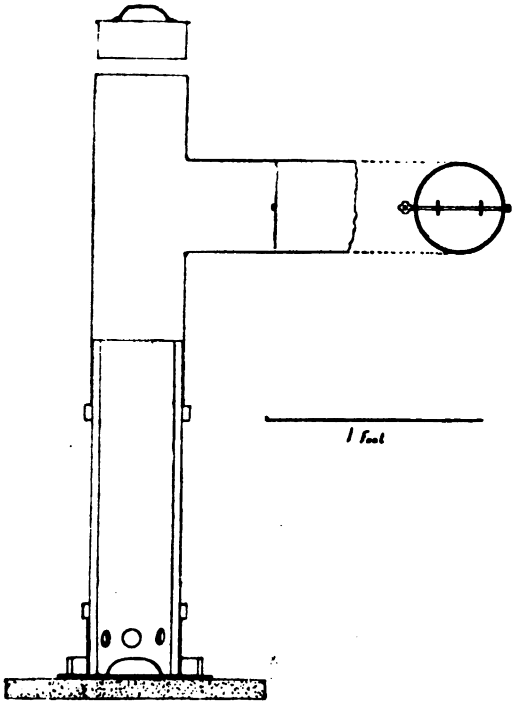

Fig. II.

It became necessary, at the outset of our work, to contrive an apparatus for preparing the ash. We accordingly constructed a burner, of which a section is shown in Fig. II.

The burner consists essentially of a bunsen-like tube, standing on a piece of sheet iron above asbestos, and communicating with the chimney by a valved branch at right angles near the top. A little distance above this, the straight portion of the tube can be closed by a loosely-fitting cover, through which the charge is fed. This having been introduced, the lid is let down, and, by means of an ordinary gas burner, placed at one of the lower orifices, kindling is easily effected. The rate of combustion can be doubly regulated by means of the chimney-valve and the usual bunsen ring; the progress of the combustion is of course inspected from time to time by lifting the lid. We had no difficulty with this arrangement in burning the wood with all desirable slowness.

The analytical determinations presented no features of special importance. It may, however, be desirable to mention that we obtained our silica by evaporating a portion of the averaged ash with an excess of pure concentrated sulphuric acid, and subsequently extracting with dilute hydrochloric acid. In this way the silica became very dense, and none went into solution.

In the following table we give the numbers of sections, weight of crude ash, weight of ash after burning at a low temperature until constant ("corrected ash"), percentage on corrected wood, and weights of sections in grammes.

TABLE I.

No. of Section.	Ash.	Corrected Ash.	P.c. of corrected Ash on Wood.	Weight of Section.
1	49·10 grms.	44·068 grms.	1·0503	4195·708 grms.
2	127·65 ,,	113·400 ,,	1·4612	7760·64 ,,
3	201·10 ,,	165·322 ,,	1·9177	8646·56 ,,
4	114·70 ,,	98·638 ,,	2·0960	4706·00 ,,
5	133·20 ,,	126·201 ,,	2·2314	5655·70 ,,
6	96·95 ,,	88·902 ,,	2·3842	3727·94 ,,
7	102·30 ,,	97·916 ,,	2·4848	3940·57 ,,
8	50.40 ,,	45·443 ,,	2·4661	1842·71 ,,
9	45·30 ,,	41·493 ,,	2·4496	1693·88 ,,
10	47·90 ,,	44·970 ,,	2·1730	2069·51 ,,
11	17·20 ,,	15·901 ,,	2·4929	637·86 ,,
12	4·30 ,,	3·450 ,,	1·9576	176·20 ,,
13	7·911 ,,	6·728 ,,	2·7349	246·00 ,,
14	0·9618 ,,	0·856 ,,	3·2797	26·10 ,,

In the following table we give the total silica in each section and the corresponding percentage in the corrected ash.

TABLE II.

No. of Section.	Silica.	P.c. of Silica in corrected Ash.
1	6·865 grms.	15·578
2	25·997 „	22·907
3	43·377 „	26·159
4	25·203 „	25·552
5	30·795 „	24·402
6	20·864 „	23·468
7	22·309 „	22·783
8	11·403 „	25·098
9	9·668 „	23·300
10	10·434 „	23·201
11	4·3937 „	27·300
12	0·7721 „	22·381
13	1·6724 „	24 857
14	·3532 „	41·263

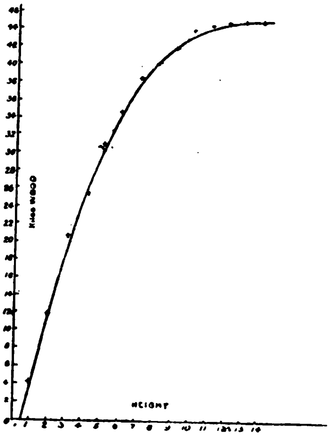

Fig. III.

Wood Curve.—Fig. III. shows the relation between the height and weight of wood. The smoothed curve is drawn to the equation.

$(45{\cdot}377 - y) = b\,(13{\cdot}724 - h) + c\,(13{\cdot}724 - h)^2 + d\,(13{\cdot}724 - h)^3$ where $b = 154{\cdot}71$, $c = 28{\cdot}302$, $d = 17{\cdot}097$, and h = the height, reckoned in terms of sectional units.

As might have been expected, the divergencies between calculation and experiment are greater in the wood curve, which necessarily represents at their largest every variation due to weather, season, and similar conditions. Some uncertainty also arises from the presence of an abnormal small bough on the otherwise bare portion of the bole just above the root.

ASH CURVE.—Fig. IV. shows the relation between the amount of "corrected ash" to a given height in the tree. The smoothed curve has the equation.

$883{\cdot}72 - y = b\,(13{\cdot}724 - h) + c\,(13{\cdot}724 - h)^2 + d\,(13{\cdot}724 - h)^3$ where $b = -11{\cdot}916$, $c = 4{\cdot}3935$, and $d = {\cdot}15232$.

Calculated and observed values are contrasted below:—

TABLE III.

h.	y obs.	y calc.
[1]	[44·07]	[10·24]
2	157·47	174·07
3	323·29	318·38
4	421·93	444·10
5	548·13	552·16
6	637·03	643·45
7	734·95	718·89
8	780·39	779·41
9	821·88	825·91
10	866·85	859·29
11	882·75	880·50
12	886·20	890·42
13	892·93	889·99
14	893·79	880·10

The probable error per cent. of the average weight determined is 2·16; this, however, would be much reduced if we were to omit section 1, which is probably too near the root to be fairly included in the calculation.

SILICA CURVE.—Figure V. shows in like manner the amount of silica as a function of the height of the tree.

On making the necessary calculations for the curve, it soon became evident, from the course of the numbers, $h = 3{\cdot}1$ was a critical point. Taking this as an arbitrary parameter, the equation for the smoothed curve is:—

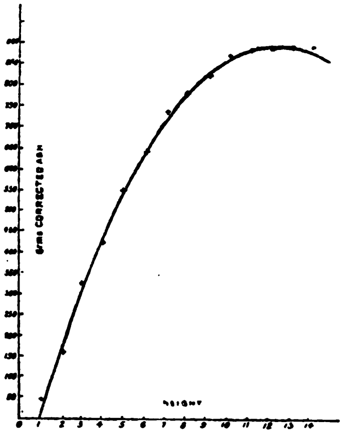

Fig. IV.

$$y = 84{\cdot}694 + 31{\cdot}565(h - 3{\cdot}1) - 2{\cdot}481(h - 3{\cdot}1)^2 + 06026(h - 3{\cdot}1)^3.$$

On differentiating this equation, another important critical point was found at $h = 13{\cdot}724$. This result remained practically constant even when we several times recalculated the curve with slight tentative modifications of the arbitrary parameter above referred to. It is convenient, then, to put the equation in the form:

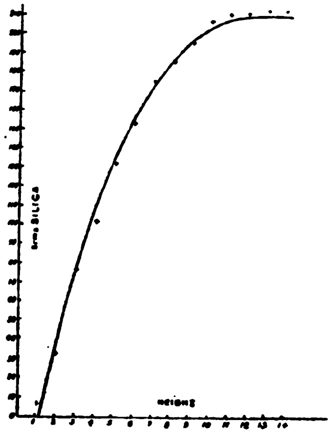

Fig. V.

$210{\cdot}27 - y = b\,(13{\cdot}724 - h) + c(13{\cdot}724 - h)^2 + d\,(13{\cdot}724 - h)^3$, where $b = -1{\cdot}0326$, $c = +{\cdot}43006$ and $d = +{\cdot}077406$, and to express the other equations in a similar manner.

The calculated and experimental values of y are :

TABLE IV.

h.	y obs.	y calc.
[1]	[6·87]	[5·68]
2	32·86	38·53
3	76·24	76·42
4	101·44	108·48
5	132·24	135·153
6	154·09	156·922
7	175·40	174·240
8	186·80	187·576
9	196·47	197·393
10	206·91	204·157
11	211·30	208·330
12	212·07	210.378
13	213·74	210·766
14	214·10	209·957

From a comparison of theory with experiment it appears that the probable error per cent. on the average weight calculated is 1·48. Here, also, it would doubtless have been fairer to omit Section 1.

The point $h = 3{\cdot}1$ indicates the theoretical position at which the chemical effect of the unexposed trunk as a mineral carrier is at its lowest. It originates, doubtless, with the sudden demand for ash by the large lowest branches which occur near there.

The upper critical point $h = 13{\cdot}724$ depends on a similar demand due to the exceptional vitality of the extreme summit of the tree. It appears that this demand is so sudden as to be to a slight extent oversatisfied.

PART II.—LIME.

By EDMUND J. MILLS, D.Sc., F.R.S., and ARCHIBALD GRAY.

The hydrochloric extract of the silica in Part 1 contained, of course, the lime of the ash. This was determined by the usual methods, and doubly precipitated in order to ensure the absence of magnesia. As in the case of the silica, the determinations were all in duplicate, and we report the means of these.

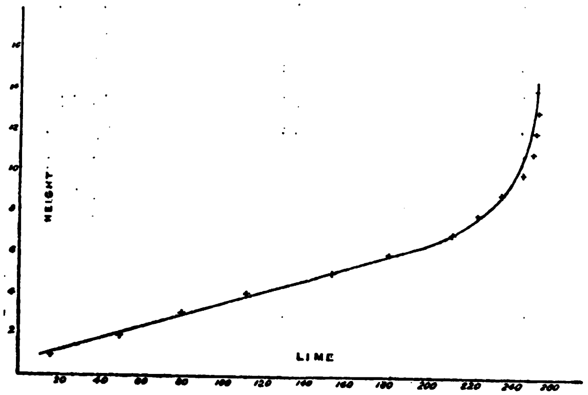

Fig. VI.

TABLE V.

		Lime (cal.)	grams.
Section	1	15·111	,,
,,	2	34·207	,,
,,	3	30·709	,,
,,	4	36·909	,,
,,	5	35·918	,,
,,	6	27·796	,,
,,	7	31·840	,,
,,	8	11·743	,,
,,	9	11·920	,,
,,	10	10·535	,,
,,	11	3·812	,,
,,	12	1·0412	,,
,,	13	·8747	,,
,,	14	·0149	,,

If these weights be consecutively added (y), the relation of their sums to the corresponding heights (h) can be fairly represented by the equation.

$252{\cdot}49 - y = (14 - h)b + (14 - h)^2 c + (14 - h)^3 d$, where $b = {\cdot}89571$ $c = -{\cdot}20992$, $d = {\cdot}14045$.

TABLE VI.

h.	*y.*	*y* calc.
3	80·027	81·099
4	116·996	124·674
5	152·914	159·044
6	180·710	186·848
7	212·550	208·331
8	224·293	224·335
9	236·213	235·703
10	246·748	243·277
11	250·560	247·900
12	251·601	250·414
13	252·475	251·663
14	252·490	252·490

The probable error of a single comparison is 2·71 = about 1·7 per cent. on the average quantity determined. Much of this, however, may (as in the other cases) depend upon casual phenomena otherwise connected with the growth of the tree.

A drawing of this curve is given in Fig. VI.

If the numbers in the vicinity of $h = 3$ be put in the form $y = a + bh + ch^2$, it appears that $-\dfrac{b}{2c} = 2{\cdot}5$, – a critical lower point somewhat below the silica lower point. Taking the corresponding values

h.	*y.*
3	80·027
6	180·71
9	236·21
12	251·60

the equation can be put in the form, $y = a + b\,(h - 2{\cdot}5) + c\,(h - 2{\cdot}5)^2 + d\,(h - 2{\cdot}5)^3$ where $a = 58{\cdot}497$, $b = 44{\cdot}470$, $c = -2{\cdot}83389$ $d = {\cdot}031315$; which could give $h = 30{\cdot}219$ as an upper critical point. It is obvious that this point is quite of an ideal character, being above the actual summit of the tree.

Although we have indicated lower and an upper critical points in the bole only, it would seem reasonable to suppose that similar points must occur in all branches, and even twigs.

Professor Mills afterwards showed his Artiograph or Curve-smoother—an instrument whereby the smoothing of experimental curves is much facilitated, and which may also be used for drawing curves. A description of this is reserved for a future occasion.

X.—*On the Thermal Conductivity of Substances of very low Conductivity.*

BY

VINCENT J. BLYTH, M.A.

[Read before the Society, 7th March, 1900.]

IT is the purpose of this short paper to describe a series of experiments undertaken at the suggestion of Lord Kelvin, with a view to the determination of the thermal conductivity of certain substances whose conductivity is low, and to give some of the results obtained.

Since the comparative experiment of Ingenhauz, in 1789 much has been done by Forbes, Tait, Kelvin, Angstrom, and others in the subject of thermal conductivity, but most of these experimenters have directed their attention to metals and highly conductive substances; and not so much has been done in the investigation of materials of low conductivity or "heat insulators" as they have been called. In 1873 Stephan (1) determined a result for the conductivity of air which closely agreed with the value obtained by Maxwell from calculations based on the kinetic theory of gases. Within more recent years researches conducted by Lamb and Wilson (2) have determined results for air, paper, felt, asbestos, and a heat insulator known as "kapok"; and in an elaborate paper, by Milner and Chattock (3), on the conductivity of water, a result for cotton wool is given. Still more recently an investigation of the conductivity of vulcanite has been made by Osgood Pierce (4).

It was primarily for the purpose of determining the insulating efficiency of kieselguhr that the experiments to be described were made. Kieselguhr is a siliceous earth of infusorial origin, variously known as diatomite, infusorial earth, or fossil meal. It occurs in deposits in a fairly pure state, notably in the Lauenburg district of Germany, in Antrim, and in the Island of Skye. It owes its importance chiefly to its highly absorbent properties, in virtue of which it is used as the absorbent for nitro-glycerine in the manufacture of dynamite. But it also promises to become important on account of its heat insulating properties which render it an efficient lagging for boilers and steam-pipes, and a valuable fire-proof covering for buildings; it is also useful in many ways for various experimental purposes, being much more easily packed than cotton wool. The specimen of kieselguhr experimented on was obtained for me by Professor Magnus Maclean from the Skye Diatomite Company.

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(1) Jour. de Phys., tom. II. p. 147.

(2) Roy. Soc. Lond., June, 1899.

(3) Phil. Mag., July, 1899.

(4) Phil. Mag. Jan., 1900.

The method of experiment adopted was a direct one, in which the simple relation expressing the definition of thermal conductivity was used:—

$$k = \frac{Qd}{A\,(\theta_1 - \theta_2)\,t} \quad - \quad - \quad (1)$$

where k is the conductivity of the substance, and Q is the quantity of heat which flows in time t through a slab of the material of thickness d between two parallel faces each of area A and at temperatures θ_1 and θ_2 respectively, the direction of flow being normal to these faces and the flow being steady.

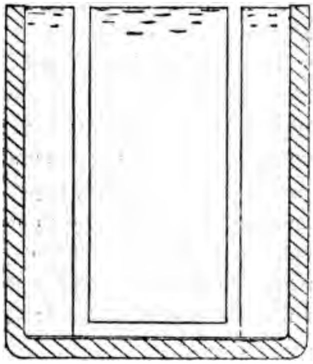


Fig. 1.

The first apparatus (Fig. 1) to be used, consisted of two concentric cylinders of thin copper, (·56 mm. thick) of diameters 6·2 and 7·6 cm. and lengths 14·8 and 16·7 cm. respectively. The outer of these cans was warmed from without by a current of hot water or steam; the inner can was suspended within the outer by threads, and was gradually warmed by heat conducted to it from the outer through the substance under test which occupied the space between the cans. The temperatures of the cans were measured by means of thermo-electric junctions of copper and nickel soldered to them; and these junctions could, by means of a switch (Fig. 2) be connected up in series with a galvanometer, or, either could be thrown into a circuit containing the galvanometer and a third junction which was kept at a known temperature in cold water or melting ice. These junctions were first carefully standarized; those which were to be soldered to the cans were bound to the bulb of a standard thermometer and immersed in a vessel of water whose temperature could be varied, while the third junction (also bound to a thermometer) was kept in melting ice. A number of readings of temperature differences and corresponding galvanometer deflections were taken, and a curve drawn from which the temperature difference corresponding to any galvanometer deflection could be obtained.

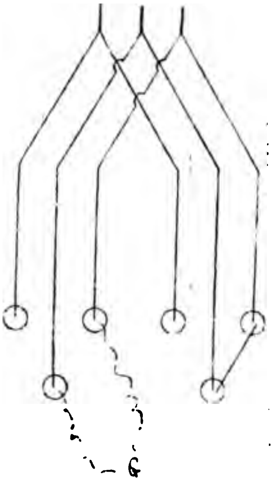


FIG. 2.
THERMO JUNCTIONS.

Before the experiments proper were begun, some trials were made to discover the effect of interposing between the two cans one or more similar concentric cylinders. For this purpose the inner can was left empty and simply exposed to the air, and the results of interposing (i) one, and (ii) two cylinders were compared (the cylinders being kept separate by asbestos cord). The results obtained are shown in the following table:—

	Temperature of outer can.	Steady temperature attained by inner can.	Difference.
No cylinders interposed,	79·3	56·5	22·8
One cylinder interposed,	79·8	59·5	20·3
Two cylinders interposed,	80·5	60·9	19·6

These results show that the effect of the interposition of a cylinder was equivalent to that of diminishing the distance apart of the cans by the thickness of the cylinder interposed.

For the measurement of conductivities the inner can was filled with a known mass of water, in order to determine the quantity of heat flowing per second through the substance. After the state of steady flow had been arrived at, and the temperatures of the cans measured, the current of hot water was cut off and the rate of cooling of the inner can was observed for a short time. On the assumption that this was equal to the rate of cooling due o loss of heat by evaporation and radiation at the surface of the water, and therefore gives the rate of flow of heat through the substance, the following results were obtained.

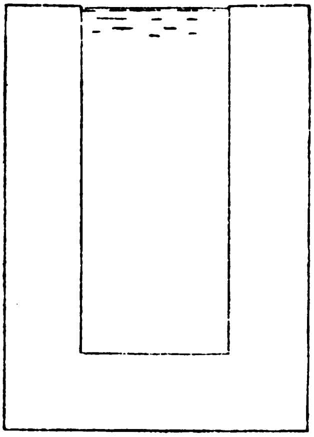


FIG. 3.

For Kieselguhr, k = ·0000772.
„ Air, k = ·0000553.
„ Asbestos, k = ·0000752.

With a view to finding more accurately the rate of loss of heat from the inner can when the system is in a state of steady flow, the following experiment was made. The inner can was immersed in a large vessel of kieselguhr and filled with hot water (Fig. 3); it was then allowed to cool by evaporation and radiation at the surface, and by loss of heat conducted through the kieselguhr, the temperature of the can being read at intervals during cooling. If r = the rate of cooling of the can, and M = the water equivalent of the can full of water, then $M\ r\ t$ = the heat lost in time t, but $\frac{k\ A^1\ (\theta_1^1 - \theta_2^1)\ t}{d^1}$ = the heat lost in time t by conduction through the kieselguhr [where A^1, θ_1^1, θ_2^1, d^1 correspond to A, θ_1, θ_2, d in equation (1)].

$$\therefore\ M\ r\ t - \frac{k\ A^1\ (\theta_1^1 - \theta_2^1)\ t}{d^1} = \text{the heat lost in time } t$$

by evaporation and radiation, - - - - - - (2)

whence [substituting this expression for Q in equation (1)]

$$k = \frac{M\ r\ d\ d^1}{A\ (\theta_1 - \theta_2)\ d^1 + A^1\ (\theta_1^1 - \theta_2^1)\ d} \quad - \quad - \quad - \quad (3)$$

The value thus obtained for kieselguhr was used in the equation (2) to find the value of Q, and in this way the conductivities of other substances were obtained. The values got by this method, however, were considerably higher than those otherwise obtained, the reason being that in the calculations no account was taken of the heat emitted at the exposed surface of the kieselguhr in which the can was immersed in the cooling experiment. To make allowance for this loss of heat would involve a knowledge of the emissivity of kieselguhr, and until this quantity has been determined the results of this method cannot be properly evaluated.

For the purpose of measuring still more accurately the quantity of heat flowing through the substance under test, a new apparatus was made, consisting of two concentric hollow spheres of thin copper of diameters 10·25 and 12·7 cm. (Fig. 4). The temperatures of the two spheres were measured, as before, by means of thermo-junctions. The heat, however, in this case, was supplied by a current-carrying platinum spiral inside the inner sphere. The substance under test occupied the space between the spheres, so that when the temperatures attained by the inner and outer spheres were steady, the heat passing through the substance was necessarily equal to the heat generated in the spiral. The outer sphere was simply left exposed to the air, and this was found quite satisfactory since the temperature of the sphere remained constant in some cases for fifty minutes. The current in the spiral was measured by a Kelvin deci-balance, and, by a previous determination, the resistance of the spiral was known at all temperatures.

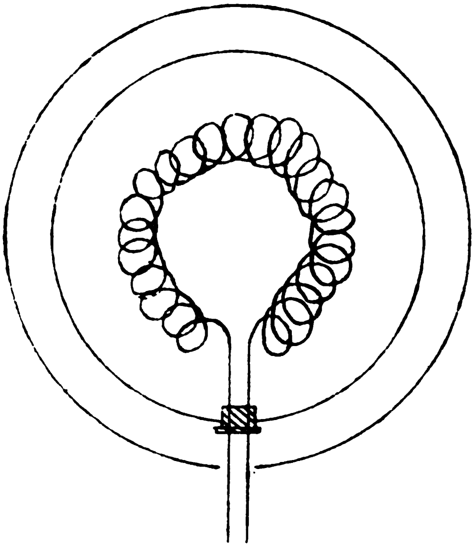


Fig. 4.

By using the equation

$$k = \frac{C^2 R d}{A(\theta_1 - \theta_2)} \quad - \quad - \quad - \quad (4)$$

(Where C = the current in the spiral,
R = the resistance of the spiral at the temperature of the inner can,
d = the distance between the spheres,
A = the effective area of material traversed by the heat,
θ_1 = the temperature of the inner sphere,
θ_2 = the temperature of the outer sphere)

the following results were obtained :—

For Kieselguhr, k = ·0000882.
„ Air, k = ·0000813.
„ Cotton Wool, k = ·0000811.

This result for air differs somewhat considerably from that obtained by the previous method, but it will be remembered that in the case of free air it is difficult to prevent or make allowance for transfer of heat by convection. The values for air at different mean temperatures are given below :—

Mean Temperature.	Conductivity.
47°C	·0000802.
61°C	·0000812.
76°C	·0000823.

These values afford an approximate verification of the theoretical statement that the conductivity varies directly as the square root of the absolute temperature.

XI.—*On the Equilibrium of a Column of Air and the Atmospheric Temperature Gradient.*

BY

DAVID ROBERTSON, B.SC., A.G.T.C.

[Read before the Society, 7th March, 1900.]

THE following remarks are the results of noticing a phenomenon which, although probably common enough in itself, seemed rather curious at the time. One misty morning about the beginning of the year, when there was no wind, it was found when lighting a fire that there was a marked down-draught in the chimney which blew the smoke into the room. A lighted newspaper was then thrust up the chimney but still the flames were blown down. At last, however, just before the paper had all burned away, the air current was reversed and the chimney began to draw properly. What appeared to be remarkable was that although the down-draught had been so decided a moment or so before, this upward flow was now equally strong in spite of the fact that the fire had fallen so low, and was giving off such cold smoke, that its contribution towards the maintainance of the draught must have been quite negligeable.

This showed that is was possible to have such conditions that either a downward or an upward flow in the chimney would be stable when once started, and it is easily explained in the following manner.

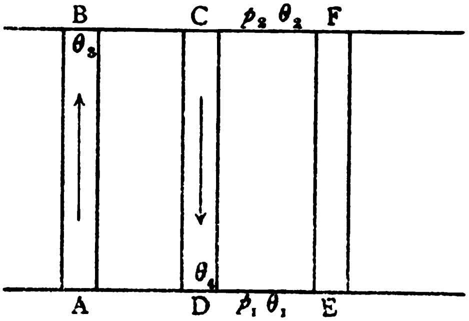
Suppose the outside air at the top of the chimney to be considerably colder than at the level of the bottom, and also that the air in the room is warmer than at the top of the chimney. Now let a downward current be started so as to fill the chimney with cold air from the top. This air will be denser, and therefore heavier than the corresponding column outside, and will consequently continue to fall after it is left to itself, so long as the difference of temperature is sufficient.

On the other hand, if we start an upward current we shall fill the chimney with warm air from the room, and this will now be lighter than the outside column, and will therefore be forced upwards by the greater weight of the latter. This upward flow will thus also be maintained by the action of gravity until the difference of temperature is reduced too far. Thus both circulations tend to alter the distribution of heat so as to bring the difference of temperature to a certain limit.

The same reasoning shows us that if we could get the air in the chimney at rest under these conditions a small displacement of the air in either direction would cause a flow to start in that direction, and the equilibrium would therefore be unstable.

The chimney referred to leads from the basement, and its length of somewhere about fifty feet will account for the great stability which each current showed.

In order to find the limiting range of temperature when the air is quite dry, or at least uniformly moist, consider any two level surfaces A D E and B C F, and imagine them connected by two vertical shafts A B and C D. Let p_1, θ_1, be the absolute pressure and temperature at the lower level A D E, and p_2, θ_2, their values at the higher level.



Now let currents of air be started in these shafts as shown by the arrows, so that A B becomes filled with air from the lower level, and C D from the upper. Owing to the expansion of the air with diminished pressure the temperature in A B will now fall from θ_1 at A to θ_3 at B; and in C D, where the air gets compressed as it falls, the temperature will rise from θ_2 at C to θ_4 at D. Since in our final result we shall have the temperature of the columns everywhere the same as that of the immediately surrounding atmosphere, we can assume the expansion and compression to be adiabatic. In that case it is obvious that if θ_3 is greater than θ_2, θ_1 will be higher than θ_4, and the temperature of any part of A B will be greater than at the same level in C D.

The column C D will therefore be denser and heavier than A B and the circulation started will be continued by gravity.

On the other hand, if θ_3 be smaller than θ_2, θ_1 will also be lower than θ_4, and the column C D will consequently be warmer and lighter everywhere than at the same level in A B. The result is, that gravity will oppose the circulation, which will therefore stop when left to itself.

This shows us that if θ_2 be lower than what we would get by adiabatic expansion from p_1, θ_1, to p_2, the equilibrium will be unstable, and circulation will take place, carrying heat upwards and cold downwards by convection, until this relation is satisfied; but if θ_2 be greater than this, the equilibrium will be stable, and circulation cannot take place of itself.

We get the same result by comparing each column A B and C D in turn with a stationary column E F, when we make the additional assumption that the temperature varies in such a way from E to F that the weight of a column E F is greater or less than that of an equal column with adiabatic temperatures according as its range of temperature is less or greater than in the adiabatic, both starting from the same point.

Our result will be true for all differences of height on this assumption, but when we take small distances, so that the temperature cannot vary erratically, the assumption is not necessary.

We are therefore led to the conclusion that in a dry atmosphere at rest, the temperature gradient at any point cannot be steeper than that of the adiabatic expansion containing the conditions at that point; but it may have any smaller value, and may even be negative.

If, then, we draw a temperature-pressure chart, with a number of adiabatic curves marked on it, and plot on it a set of simultaneous values of the temperatures and pressures at different levels in a still, dry atmosphere, the curve representing the actual temperatures can only cross the adiabatic lines from the side of higher temperature towards that of lower temperature as we go along it in the direction of increasing pressure.

Let p_1, v_1, θ_1, be absolute pressure, volume, and temperature of one pound of air at any datum level.
and p, v, θ, their values at any other level.

Then, from Boyle's and Charles' laws :—

$$R\theta = pv; \text{ and } R\theta_1 = p_1 v_1.$$

$$\therefore \quad \frac{\theta}{\theta_1} = \frac{pv}{p_1 v_1} \qquad (1)$$

But, for adiabatic expansion:—

$pv^\gamma = p_1 v_1{}^\gamma$ where γ is a constant.

Or, $$1 = \frac{pv^\gamma}{p_1 v_1{}^\gamma} \qquad (2)$$

Equation (1) gives $$\left(\frac{\theta}{\theta_1}\right)^\gamma = \frac{p^\gamma v^\gamma}{p_1{}^\gamma v_1{}^\gamma} \qquad (3)$$

Divide (3) by (2) and we get:—

$$\left(\frac{\theta}{\theta_1}\right)^\gamma = \frac{p^{\gamma-1}}{p_1{}^{\gamma-1}}$$

$$\therefore \quad \frac{\theta}{\theta_1} = \frac{p^{\frac{\gamma-1}{\gamma}}}{p_1{}^{\frac{\gamma-1}{\gamma}}}$$

Or $$\theta = \left(\frac{p}{p_1}\right)^{\frac{\gamma-1}{\gamma}} \theta_1 \qquad (4)$$

For dry air γ = 1·408 nearly, and a number of curves are plotted on the chart shown from equation (4) with this value of γ. Each curve is drawn so as to have a different value of θ_1 for one value (30 inches of mercury) of p_1. They are most easily obtained by calculating out a number of points for one by the aid of logarithms, and then increasing all the ordinates in the same ratio (counting, of course, from the absolute zero), to obtain a new curve. A succession of curves can then be found by stepping up with dividers from the last curve on each ordinate a number of distances, each equal to that between the two first curves, measured along that ordinate.

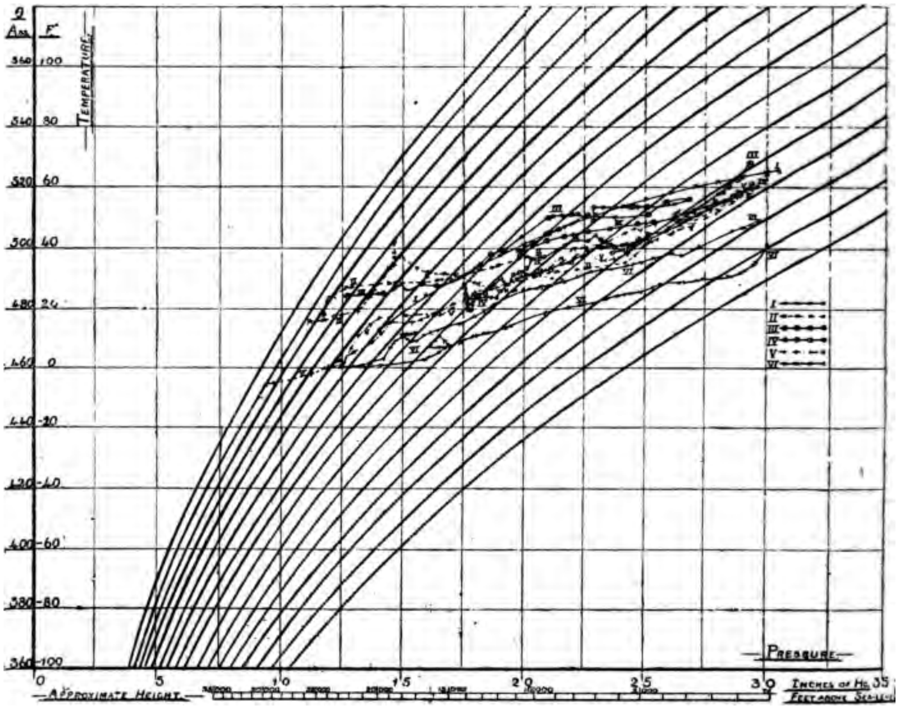
When the air is damp γ will probably have a lower value, and when the proportion of moisture by mass is variable we have further complications due to the difference in density of air and water vapour. Both these, however, will reduce the gradient, and we may therefore expect our result to give the maximum possible steepness, and hence the lowest possible temperature, at any given height from the earth's surface, when the atmosphere is in equilibrium.

For comparison, a few sets of results obtained by Glaisher in his balloon ascents are marked on the chart, and it will be observed that, on the whole, the curves showing them are all considerably less steep than the adiabatic curves. This shows us that for the times and places of these ascents, the conditions are, in general, such that there can be no local vertical circulation of the air except any that may be caused by water vapour. We are therefore justified in the conclusion that the upper strata of the air in this part of the world receives its heat by the absorption of the radiation passing through it, and through winds from warmer regions. Practically none is obtained from the earth's surface in its neighbourhood by convection of the air, although there may be some heat carried up locally by moisture. In this connection it would be interesting to have similar sets of readings for a hot inland district such as the Sahara. We should expect a much steeper gradient there.

One or two curves, especially III. and VI., show a greater gradient nearer the ground, and we may suppose that convection was taking place there. There are also some irregular parts which are steeper than the adiabatic, but these are so small and of such a nature that we cannot be quite sure of them, although there is no reason why we should not have local circulations at different heights. This might be caused, for example, by the upper surface of a cloud absorbing the sun's rays and so becoming warmer than the air above it. It will be observed that most of these irregularities could be converted either into a smaller positive gradient than the adiabatic, or into a negative slope, by a very small alteration of the pressure.

We must therefore bear in mind the circumstances under which the observations were made. First of all, the readings are not all taken at one time nor in one vertical line, but, as will be seen from the table, are spread over several hours. This is shown in the difference between the curves for the ascent and for the descent. Most of those plotted were made in the morning or in the early afternoon, while the atmosphere was being warmed up by the sun's rays. This reduces the apparent gradient for the ascent and increases that for the descent. The last one, however (VI.), was made under the reverse conditions, and the curve for the descent lies below that for the ascent. The arrow heads on the curves show the order in which the observations were made.

Again, the corresponding readings of pressure and temperature are not always quite simultaneous; in many cases they had both to be made by one observer, and of course he could not read both instruments at once. This would make a perceptible difference when the balloon was moving rapidly. No allowance seems to have been made for the possible effects of the inertia of the apparatus; this might produce an appreciable error in their readings, especially of the mercury barometer, when the balloon is spinning rapidly, as it often did, or when its vertical motion is changing. Lastly, when we come to deal with the actual atmosphere we have to do with a body of air which is neither at rest nor free from moisture.



Curve No I. is of a different character to the others. This is principally due to the method in which it was obtained. Sir John Herschel collected the readings from nine ascents, plotted them, and drew a smooth curve in a single sweep for each set. He then measured the temperatures from these curves, and calculated the means from the values so obtained.

An approximate scale of heights has been added. This has been obtained from Glaisher's calculations for curve No. V., and will only be approximate for the others.

The table gives particulars of the different curves.

INDEX TO CURVES.

No.	Reference.	Observer.	Place.		Date.	Time.			Height of Clouds. A = Ascent. D = Descent.	Remarks.
			Ascent.	Descent.		Start.	Top.	Finish.		
I.	Mean of Nine Ascents collected by Herschel in his "Meteorology," page 32.	Gay Lussac.			17th Sept., 1804.					
		Green and Rusk			4th Sept., 1838.					
		Do.			10th do.					
		Do.			22nd June, 1850.					
		Do.			29th do.					
		Welsh.			17th Aug., 1852.					
		Do.			26th do.					
		Do.			21st Oct., 1852.					
		Do.			10th Nov., 1852.					
II.	B. A. Rep., 1862, p. 376, etc.	Glaisher's 1st.	Wolverhampton.	Langham, Rutlandshire,	17th July., 1862.	9.42 a.m.	11.5	11.45	A 4,000 to 8,000 D 12,000 & und.	W. Wind, Cloudy.
III.	Do. do.	Do. 3rd.	Do.	Solihul, near Birmingham.	18th Aug., 1862.	1.3 p.m.	1.20 2.59	4.5	3,000 to 4,000	Little Wind, N.E.
IV.	Do. do.	Do. 5th.	Mill Hill, near Hendon.	Near Woking.	21st Aug., 1862	4.30 a.m.	5.51	7 10	4,000 to 7,000	
V.	Do. do.	Do. 7th.	Wolverhampton.	Tilbury Fort.	5th Sept., 1862.	1.3 p.m.	1.53	3.6	A 6,000	
VI.	Do. 1863, p. 426.	Do. 9th.	Crystal Palace.	Barking Side, Essex.	31st Mar., 1863.	4 16 p.m.	5.45	6.30	Cloudless.	Light E. Wind.

XII.—*On Molecular Unrest in Solids.*

By PROFESSOR SIR W. ROBERTS-AUSTEN, K.C.B., D.C.L., F.R.S.

[Delivered before the Society, 18th April, 1900.]

MORE than twenty years ago I delivered the first Graham Lecture before this Society, my selection being due to the fact that I was the last to have the good fortune to be associated with Graham in his scientific work which only ended within a few weeks of his death in 1869. In the thirty years that have passed since Graham left us, the importance of the labours of his life have become more and more evident, and many workers have been stimulated by his example to investigate as patiently as he did the varied phenomena the basis of which is Molecular Mobility. It will probably be more useful to trace the gradual effect of Graham's teaching in relation to a few branches of scientific work than to attempt to cover the whole range of his influence.

The starting point is afforded by Graham's statement that the three conditions of matter, gaseous, liquid and solid, probably exist in every liquid or solid substance, although one condition predominates over the others. "Solidification may not, therefore, involve the suppression of either the atomic or molecular movement, but only the restriction of its range." It is easy to understand the mobility of a gas, and gaseous movement formed the subject of many of Graham's Memoirs, but there may be some here who are not familiar with the experiment by which this mobility can be readily demonstrated. I will therefore place this bell-jar filled with hydrogen over a porous cell containing air and communicating with a receptacle filled with water, by means of a tube fixed to its base; it will be seen that the hydrogen rushes in, and by rapidly displacing the air produces a fountain. In this case the gas passed through a porous medium, but the passage of hydrogen will still be rapid if a red-hot solid partition equal in thickness to the porous cell, but of iron, platinum or palladium separates the gas from a vacuous space. [The experiment of passing hydrogen through the walls of a palladium tube, a millimetre thick and heated to 400°C was then shown.]

There is, however, another method by which air may pass through a septum into a vacuum. In 1879 I showed you that air passing into a vacuous space through a thin septum of india-rubber contains 41·6 per cent. of oxygen instead of the normal amount of 21 per cent. This mode of passage may best be explained by the aid of the following experiment. A soap bubble filled with air is placed in an atmosphere containing ether, which rapidly passes through the walls of the soap bubble, and may be burnt at the end of the glass tube to which the soap bubble is attached. The mode of passage of gases through the india-rubber resembles that of the ether through the soap bubble, for the ether is dissolved in the film and evaporates on its inner side. In the case of the india-rubber, oxygen is more soluble in the semi-solid layer than nitrogen is. Both gases pass through and evaporate on the inner side, but more oxygen than nitrogen is transmitted, and the air which passes through the bag of india-rubber therefore rekindles a glowing splinter of wood. This passage of gases through the colloid india-rubber which occupies an intermediate place between a liquid and a solid, leads us a step further in the consideration of our subject, but I will only offer one illustration of the interest of Graham's work in relation to the passages of gases through colloids. It is connected with the great discovery of argon, by Lord Rayleigh and Professor Ramsay. If argon differs from nitrogen it may penetrate india-rubber at a different rate, and the fact that the dialysis of air should prove to be of interest from the point of view of the argon it contains, became obvious directly the great discovery of argon was announced at Oxford in 1894. In the course of the winter of that year I made experiments with a view to ascertain what the rate of passage of argon through india-rubber would be. The desirability of making the same experiment had not, however, escaped Lord Rayleigh to whom I gladly offered any manipulative experience I possessed in conducting such experiments, and he has recently stated * that the

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* Phil. Mag., Feb., 1900, p. 220.

result of passing air through a single film of india-rubber, is to increase the proportion of argon, considered in relation to the nitrogen, from 1·19 to 1·93 per cent. In my own experiments, a double film was employed, that is, one thin balloon of india-rubber was placed within another and cautiously filled with bran, while the inner and outer spheres were also separated by bran as is shown in the diagram (Fig. 1). The air transmitted through both films reached a mercurial pump through the inner tube connected with the inner balloon, and after the oxygen had been removed in the usual way, the nitrogen which passed through the double film was found to be associated with 2·3 per cent. of argon instead of the normal amount of 1·19 per cent. I trust it will be evident that the interest of Graham's observations on the dialysis of air has been sustained in connection with one of the greatest triumphs of modern investigation—the discovery of argon.

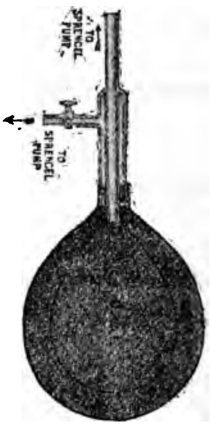

Fig. 1.

Liquid diffusion formed the subject of the Bakerian Lecture delivered by Graham before the Royal Society in 1849. The apparatus was of extreme simplicity. The salt under examination was placed in a wide-mouthed bottle immersed in a jar of water, and the rate at which the salt left the bottle and diffused into the water was ascertained. All scientific workers in Glasgow will be familiar with the magnificent experiments by which in Lord Kelvin's laboratory Graham's work on liquid diffusion is being continued. The evidence as regards the diffusion of salts was ample and clear, and it seemed to me to be a duty to extend Graham's work on diffusion, with which I had been associated, to the measurement of the diffusion of one molten metal in another.

My own experiments formed the subject of the Bakerian Lecture of the Royal Society in 1896, and the following is a brief statement of the results. It was appropriate, moreover, that the experiments should be conducted in the Mint for the following reasons. In preparing the alloy of gold and copper used for coinage, some 1,100 ounces of gold and 100 ounces of copper are melted at a time in a crucible, and the results of assays on pieces of metal which represent the first and last portions poured from the crucible need not differ by more than $\frac{1}{10000}$th part. Such a fluid mass of gold owes its singular uniformity in composition, not only to the mechanical stirring by which the blending of the gold and copper is roughly affected, but also to the fact that the metals dissolved in each other become spread or diffused uniformly by a spontaneous process. Very little attention has, however, been devoted to the measurement or even the consideration of the molecular movements in fluid metals, and the absence of direct evidence upon the point is probably explained by the want of a sufficiently accurate experimental method. An eminent physicist, Ostwald, has stated, with reference to the diffusion of salts, that "to make accurate experiments in diffusion is one of the most difficult problems in practical physics," and the difficulties are obviously increased when working with metals at high temperatures. It is, moreover, well known that the rate of saline diffusion is greatly augmented by a comparatively small increase of temperature, a fact which suggests that the thermal measurements must therefore be accurate.

The want of a ready method for the measurement of comparatively high temperatures, which led to the abandonment of the earlier work, was overcome by the use of the recording pyrometer*, and the use of thermo-junctions in connection with this instrument rendered it possible to measure and record the temperature at which diffusion occurred. Thermo-junctions were placed in three or more positions in either a bath of fluid metal or an oven carefully kept hotter at the top than at the bottom. In the bath or oven, tubes filled with lead were placed and in this lead, gold, or a rich alloy of gold, or of the metal under examination, was allowed to diffuse upwards against gravity. The amount of metal diffusing in a given time was ascertained by allowing the lead in the tubes to solidify; the solid metal was then cut into sections, and the amount of metal in the respective sections determined by analysis.

The movement in linear diffusion is expressed, in accordance with Fick's law, by the differential equation

$$\frac{dv}{dt} = k\frac{d^2v}{dx^2}$$

In this equation x represents distance in the direction in which diffusion takes place, *v* is the degree of concentration of the diffusing metal, and *t* is the time; *k* is the diffusion constant, that is the number which expresses the quantity of the metal in grams diffusing through unit area (1 sq. cm.) in unit time (one day) when unit difference of concentration (in grams per c.c.) is maintained between the two sides of a layer 1 cm. thick. The experiments have shown that metals diffuse in one another just as salts do in water, and the results were ultimately calculated by the aid of tables prepared by Stefan for the calculation of Graham's experiments on the diffusion of salts. The necessary precautions to be observed and the corrections to be made are described at length, and the values of the "diffusivity" of various metals in lead are then given. The values for *k*, the diffusivity given in sq. cm. per day, are as follows:—

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* *Loc. cit.*

	k	
Gold in lead,	3·19	at 500°c.
Gold in bismuth,	4·52	„
Gold in tin,	4·65	„
Silver in tin,	4·14	„
Lead in tin,	3·18	„
Rhodium in lead,	3·04	„
Platinum in lead,	1·69	at 490°.
Gold in lead,	3.03	„
Gold in mercury,	0·72	at 11°.

In order to afford a term of comparison, it may be stated that the diffusivity of chloride of sodium in water at 18° is 1·04.

The results of the diffusion, during twenty-four hours, of platinum and gold in fluid lead, contained in tubes placed side by side, and heated to a temperature of 500°, are represented in the accompanying diagram. (Fig. 2). The columns marked "Au." "Pt." represent the columns of fluid lead, $2\frac{3}{4}$ inches long and $\frac{3}{16}$ inch in diameter. The spheres represent the relative sizes of the buttons of gold and of platinum extracted from the several sections, shown by horizontal lines, into which the columns of lead were divided after the metal had been allowed to solidify. With regard to the curves which are marked respectively gold and platinum, the vertical ordinate represents the distance through which diffusion takes place and the abscissa concentration. Each of the metals gold and platinum which diffused into the fluid column of lead occupied, in the form of an alloy with lead, the length *a d*, of the tube, and in both cases the initial concentration of the alloy denoted by *a c*, from which diffusion proceeded, was the same, so that the area *a c e d*, represents the total amount of gold or platinum employed in the experiments, the whole quantity of either metal being initially below the line *d e*. The final state of complete diffusion would be represented by the area *a b g f*, which is the same as *a c e d*, since the quantity of gold or platinum remains unaltered. In the same manner the area *a y x f*, represents the distribution of the gold at the end of the experiment, and consequently in experiments which have lasted for equal times the nearer the curve approximates to the line *b g*, the more rapid is the diffusion of the metal it represents.

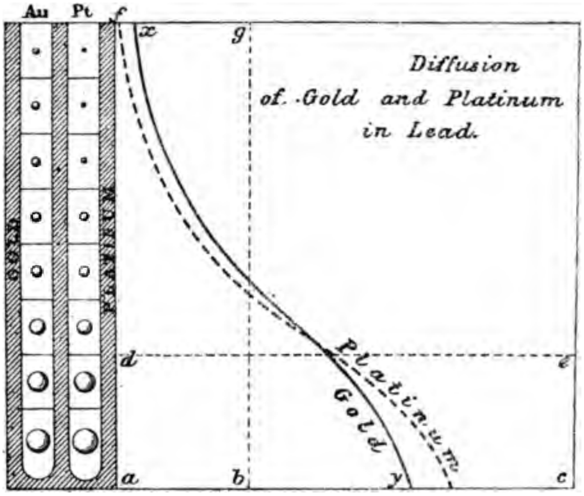

Fig. 2.

A curve indicating the diffusion of gold in solid lead would have the same general form as the curve shown above recording the diffusion of gold in fluid lead, but the time required for gold to penetrate to different points of the cylinder would be far greater in the case of solid lead than in the fluid metal. This will be evident by referring to the following figures, which give the value of *k*, that is, the diffusivity of gold in solid lead at various temperatures from 251° to 100°, and these figures show that the diffusivity of gold in solid lead at 100° is only $\frac{1}{100{,}000}$th of that in fluid lead at a temperature of 550°.

		k.
Diffusivity of gold in fluid lead at	550°	3·19
„ „ solid „	251°	0·03
„ „ „ „	200°	0·007
„ „ „ „	165°	0·004
„ „ „ „	100°	0·00002

Graham's experiments on Osmosis led to Pfeffer's classical investigations with semi-permeable media, and hence to Van't Hoff's extension of the theory of solutions to solid solutions. Van't Hoff has made it appear probable that osmotic pressure exists in solid solutions and obeys the same laws as in the case of liquid solution. If, moreover, Graham's view is correct that solidification does not involve the suppression of either atomic or molecular movement, but only the restriction of their range, it is clear that it ought to be possible to measure the rate of diffusion of one solid metal in another. The problems connected with the diffusion of solids have long interested investigators. Robert Boyle thought that "even gold" might have its "little atmosphere," while the fact that there is an interchange of matter between contiguous solids has been known from very early times. This is shown by the fact that Hebrew, and probably Egyptian metallurgists, knew how to purify gold by "cementation," while another ancient cementation process has for its object the carburization of iron and its conversion into steel. In both cases the iron and the gold remain solid, and yet are penetrated to their centres. The nature of such process has long excited keen interest. Faraday and Stodart succeeded in alloying solid metals by its aid. Le Play wondered at the mystery by which the processes were surrounded, while Gay Lussac recognised that the evidence they afford makes "it certain" that solid bodies do "act upon each other" though, as he says, "the solid state is the least favourable to the exercise of chemical affinity." I have elsewhere briefly traced * the early history of the diffusion of solids, and I will not dwell on it now as we must come to later work.

A great impulse was given to the investigation of the interpenetration of solids by the long series of experiments made by Professor W. Spring. In 1882 he made his remarkable experiments on the formation of alloys at the ordinary temperature by strongly compressing their finely divided constituent metals. In

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* Bakerian Lecture, *loc. cit.*

1885 he showed that solid barium sulphate and sodium carbonate react on each other until equilibrium is established, and in 1894 Spring added to our previous debts to him, by proving that carefully prepared surfaces of pieces of two different solid metals would unite at temperatures far below their melting points if they were placed in contact, true alloys being formed at the junctions of the respective metals. In this way all risk of mere interpenetration by the squeezing, as it were, of one metal into another was eliminated.

As has been already indicated, any one who is familiar with certain very ancient and very ordinary processes would readily accept the interaction of solids as a dominant principle in metallurgy. My own experiments on solid diffusion began in 1887 with the observation that an electro-deposit of iron adheres so firmly to a clean plate of copper that when the metals are torn apart a copper film is stripped away from the copper plate and remains attached to the iron which thus bears evidence of the interpenetration of copper and iron. This observation led me to place solid masses of gold and silver at the base of solid columns of lead and bismuth, instead of below fluid columns of those metals such as were employed in the experiments to which I have already referred, the preliminary results of which I published in 1883.* I need only state here that if gold is placed at the bottom of a cylinder of solid lead maintained at a temperature of 250°, which is more than 75° below the melting point of lead, the gold will appear in notable quantity at the top of the cylinder in less than a month. Gold will diffuse in solid lead at the very moderate temperature of 100°, which is 225° below its melting point, but the diffusivity is only $\frac{1}{100,000}$ of that which occurs in fluid lead. As regards the diffusion of gold in lead at the ordinary temperature, I have had experiments in progress for four years and, with reference to the results, I may be permitted to quote a sentence from a paper which I have sent to the Royal Society on the subject, as it sums up the general conclusion, which is this:—Gold diffuses very slowly in solid lead at the ordinary temperature, but the diffusion though slow is sure. The rate of diffusion of gold in solid lead in one thousand years is equivalent to the rate at which gold diffuses in just melted lead in a single day. Encouraged by Lord Kelvin, I am now trying to ascertain whether diffusion in the solid metal is or is not accelerated by the simultaneous passage of a strong electric current.

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* British Association Report, 1883, p. 402.

It is interesting to compare this result with Robert Boyle's suggestion that even gold may have its own auriferous atmosphere. It will be evident that gold left in a vacuum or in air for four years, would not have lost so much as it has by direct contact with lead, which acts as a solid solvent for the gold, so that the precious metal has diffused into a solid, though it would not have evaporated into a gas.

In any case there is abundant evidence of molecular unrest in solids, which naturally assumes much importance when the materials in which the movement occurs are used for industrial purposes. It is true that in a solid the molecular mean free path must be small, but if it be granted that there is rapid molecular movement in solids, such movement may in time lead to the disruption of masses to which important constructional functions are entrusted. Of course the actual molecules cannot be seen at work in solids any more than they can in the crystals which form in an ordinary saline solution. There are, however, methods by which the results of molecular movement can be observed in solids, for the molecular changes in metal are of such a nature that the results of their collective action may be measured and recorded, when the metallic mass in which they have occurred is examined by certain methods which physical science has placed at our disposal.

I will therefore take one of the most ordinary materials—steel, which, notwithstanding its reputation for solidity and rigidity, affords a remarkable example of molecular unrest. The selection of steel, moreover, enables me to trace the development of the last piece of work that occupied Graham's attention. His object was to ascertain whether it was possible to carburize iron not merely by contact with solid carbon, but by "the intervention of carbonic oxide in the usual process of cementation." If the subject is familiar enough to us now, it is in no small measure due to Graham's efforts which have borne fruit in the past twenty-four years, and it was characteristic of his work that he kept the bearing of his researches on great industrial problems constantly in view.

In order to make the demonstration of this portion of my subject as effective as possible, I have chosen the electric furnace, it being an appliance in which the carburization of metals may be readily effected. In it the most refractory metals may be fused and even volatilised; in it also, it is easy to prepare with great rapidity, from carbon-free iron, steel of the degree of carburization necessary for our immediate purpose. I have therefore selected a variety of steel containing 1·5 per cent. of carbon which is found to be very useful for making tools required for turning chilled rolls.* It is a highly carburized variety of steel, and therefore lies at the extreme limit of the steel group, but, nevertheless, when it is properly treated, it acquires very precious properties. I propose to offer certain evidence respecting the molecular history of this metal from the molten state until it is cooled to the low point which can be attained by placing it in liquid air.

Although I must limit my description to carburized iron, it may interest you to see molten baths of several carbides, such as those of chromium, nickel, and manganese, projected on the screen, each with its own distinctive, richly coloured vapour, while all are exquisite in their luminous depth and shadow. [This projection was effected by placing a mirror and a suitable lens above the opening of the furnace.] In this electrical furnace, steel of the degree of carburization I have indicated is not only melted but is boiling, and its glowing vapour, at the temperature at which the iron is melted, passes without difficulty into the gaseous atmosphere above it. For us, however, the true interest of the experiment begins with the solidification of the metal, for obviously it is with a solid mass that an investigation of the structure of the metal must begin. In the case of carbon-free iron, the metal will solidify at a point which may be fixed at 1,600°, while the particular variety of steel we are considering solidifies at a point which has been fixed by some experiments of my own at 1,380°. These temperatures can be readily measured by placing in the molten mass of steel a suitably protected thermo-couple consisting of a thin wire of platinum one end of which is twisted to a similar wire of platinum alloyed with 10 per cent. of iridium, the free ends of the wires being attached to a galvanometer, while a ray of light from its mirror passes over a scale which is graduated to correspond with the temperatures to which the thermo-couple is raised. Thus it is, that the spot of light which traverses the scale, is arrested at the point marked 1,380° when the molten steel, containing 1·5 per cent. of carbon, passes from the fluid to the solid state. Henceforth it will be obvious that any further molecular changes which occur, and are indicated by an alteration in the rate of motion of the spot of light from the galvanometer mirror, must have taken place in *solid* metal. Such changes are both numerous and complicated. Had the iron been carbon-free there would have been an arrest at about 895° followed by another arrest at 766°. In the steel in question, however, these two points are merged in a single point at 680°, at which the prolonged arrest of the spot of light from the galvanometer shows that a large evolution of heat has taken place. This is due to the separation of carbide of iron. It is this latter point which possesses the most significance for us; but I may incidentally point out that the iron lost its magnetic qualities throughout a range of temperature which probably extends from 760° to 400°. As has just been indicated, the two upper points at 895° and 766° have been merged into one at 680°, consequently the upper points have been lowered by the presence of carbon, a fact which should be remembered, as its significance will be discussed later. Profound molecular changes take place, however, at each of these critical temperatures, and it is obviously very desirable to be able to fix the structure of the steel at the moment it has entered any particular phase of interest. This may often be effected by quenching the strongly heated metal at certain definite stages of its cooling which can be readily measured by the pyrometer. If the specimens are then suitably prepared,* high magnification will reveal the structure as is shown in the accompanying Plate. In it the various changes which steel containing 1·5 per cent. of carbon undergoes, have been grouped around a central photograph which represents the variety of "cemented steel" selected for discussion. The description of the plate which follows shows the nature of the thermal treatment to which the original specimen had been subjected, either directly or in successive stages. A glance at the series of photographs will show how profound the changes sustained by the metal really are. The point to insist upon is that all of them have been effected in the solid metal, for the highest temperature to which the steel was raised, 1,050°, was 330° below the solidifying point of the steel, while the lowest was as low as that of liquid air, or 1,680° below it.

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* Seebohm, Journal. Iron and Steel Inst., 1884, Part II., p. 388.

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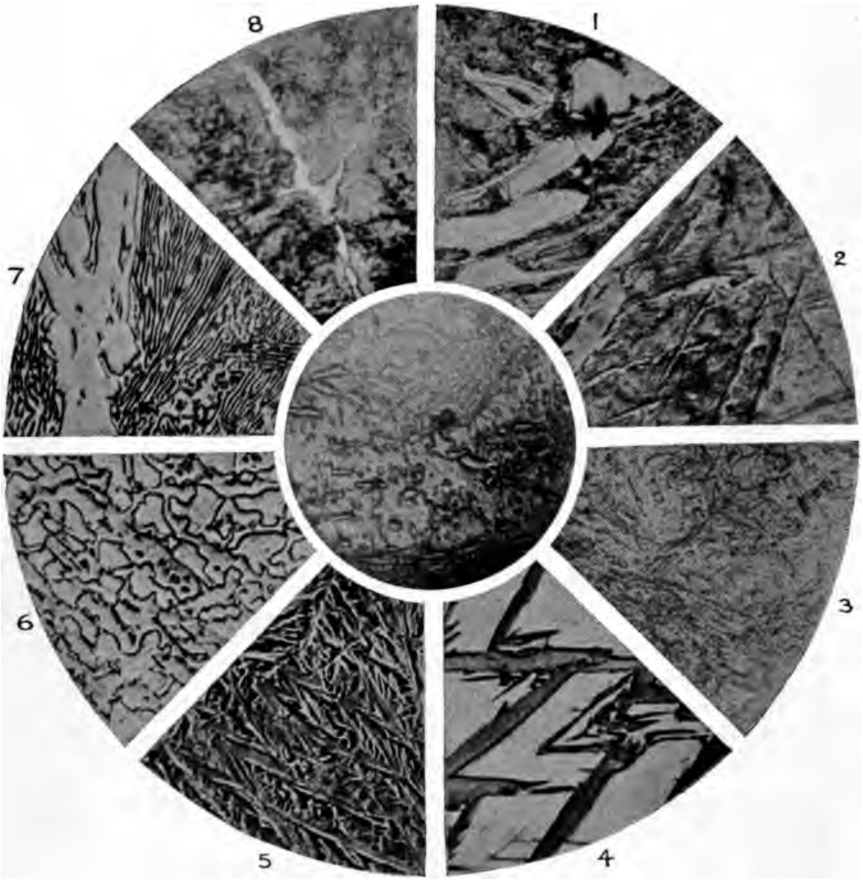
* **A Bibliography relating to the Photomicrography of Steel, is given in my "Introduction to the Study of Metallurgy." Griffin, 1898.**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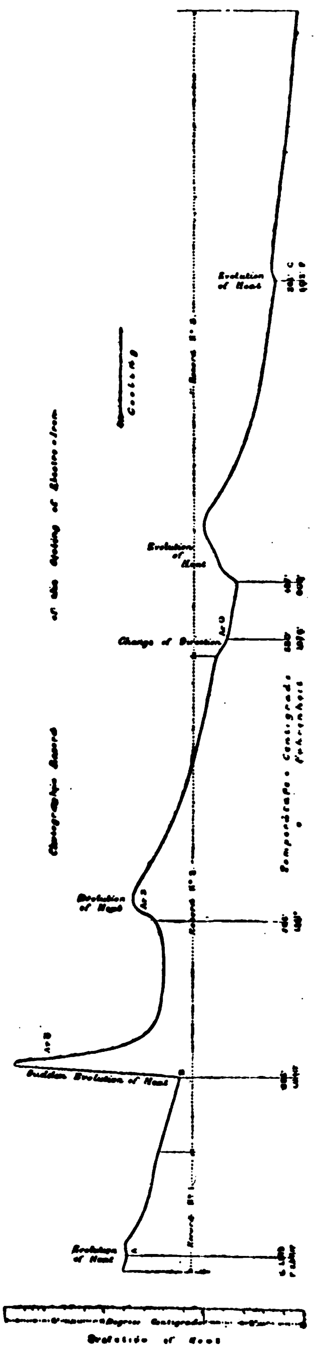
The facts may be briefly stated thus, solid iron is a solvent for carbon which passes into solid solution, mainly in the form of a carbide Fe_3C, when the iron is cooled below 1100°C. But iron is itself an allotropic body, and the particular allotropic form in which iron exists, determines the amount of carbide retained in solution by the iron as the mass cools down from 1100°. This carbide falls away from the solid solvent at 890°, because, in the case of this particular steel, the iron passes at that temperature from what is know as the γ to the β form which cannot dissolve more than 0·9 per cent. of carbon as carbide. When the temperature of the mass falls to 680° the rest of the dissolved carbide separates as laminæ.

In all the cases represented in the plate, analysis would indicate the presence of precisely the same amount of carbon, 1·5 per cent. The series begins with a section revealing the structure of the metal just as it comes from the cementation furnace. This section is the circular disc in the centre of the series. In No. 1, the steel has been heated to 1,000°, worked and slowly cooled. In it the carbide occurs in confluent masses, the ground work being made up of alternate bands of iron and carbide so that the structure resembles Mother of Pearl, the association being called "pearlite." In No. 2, the same steel has been heated to 850°, and quickly cooled in air. The confluent masses have to some extent disappeared, and there is a ground work of carbide in the distinct form to which the name "sorbite" has been given. In No. 3, the same steel has been heated to 850°, and quenched in water and has thereby been "hardened," and the resulting structure is minutely acicular the product being called "martensite." In No. 4, the interest deepens; the same steel has been heated to 1,050°, and quenched not in water but in iced brine. The result is totally different from "martensite;" there are broad chevron-like bands of "martensite" enclosing lighter and much softer portions to which the name of "austenite" has been given by its distinguished discoverer M. Osmond; but this result hardly prepares us for what happens when the steel is still further cooled by placing it in liquid air, thereby cooling it to −243°. The material, as No. 5 shows, swells up and becomes martensite or something very like it, forming a fern-like structure of singular beauty. In No. 6, the treatment has resulted in partial reversion to the original structure, but the metal has been quenched from a temperature near its melting point, and what is known as a "burnt" steel is the product. No. 7, shows the result of annealing the original steel at a temperature of 650° for a long time, followed by slow cooling; the result is better developed bands of cementite F_3C, and of the ground work of pearlite than in the specimen No. 1. Finally, by heating any of the specimens except No. 6 to 850°, working them, and allowing them to cool slowly, the structure with which we started in No. 1, is practically again obtained, as shown by No. 8.

For the sake of ready reference, the several specimens, too, have been arranged as segments of a circle round the section representing the original mass of "cement" steel, and the point I ask you to bear in mind is that these complex and varied molecular changes have occurred, except in the case of No. 6, in the solid, for in no other case has the steel been raised to a higher temperature than 1,050°, which is more than 300° below its melting point. It may be added that profound changes would have been brought about by annealing No. 3 for, say 500 hours, at a temperature of only 140°, but the structure would be too minute to be effectively shown on the scale of magnification adopted in this series.

Evidently this extraordinary case of molecular unrest has been brought about by the molecular mobility of the carbide of iron and by a remarkable molecular change of the iron itself, on which



I will not now dwell. The connection of the phenomena we have been considering with Graham's work is obvious, for the transformations present a superb case of the influence of osmotic pressure. On it depends the diffusion of the carbide in solid iron, and by it the lowering of the allotropic change points of the iron, to which I cannot further allude, has also been affected. The molecular mechanism producing the lowering of the change points is, moreover, closely connected with the molecular unrest which enabled the 1.5 per cent. of carbon contained in the steel to lower the freezing point of the solvent iron from 1,600° to 1,380°. This latter fact brings us to one other fact which is the direct outcome of Graham's work on the occlusion of hydrogen by metals. A research upon which I have long been engaged,* has placed the relations of iron and hydrogen in a new light. The cooling curve of electro-iron given in fig. 3 shows, in addition to evolutions of heat at 1,132°, 895°, and 766°, the existence of two distinct evolutions of heat which occur respectively at 487° and 261°. These points on the cooling curve were recorded after the electro-iron had been heated in vacuo to 1,300° three successive times, but after repeated heatings of the metal in vacuo, they become so small that it is impossible to identify them with certainty. There would, therefore, seem to be but little doubt that they are due to the presence of hydrogen in the iron. The upper point, that at 487°, moreover, reappears after the metal has been re-charged with hydrogen. It may be pointed out that the ordinates, showing the evolution of heat, are obtained by a differential method which is described in the Report, to which a reference has been given. There are other results, which need not be referred to here, which indicate that the molecular changes in iron are dependent upon, or are influenced by, the presence of hydrogen in the iron, and the whole investigation shows how important Graham's original observations as to the relations of iron and hydrogen are likely to prove in the immediate future.

We are learning to look at the elements present in a metal, not merely from the quantitative point of view, but from the action they exert on the solid, stimulated as that action may be by the thermal treatment to which the metal is subjected. We are beginning to realise that the mechanical properties of a metal depend on the osmotic pressure exerted by the added elements, and, therefore, that "molecular unrest," and industrial applications are closely connected. This view, it may fairly be claimed, Graham originated, and I doubt whether he would have wished any other recognition than that so universally accorded to him of being the leading atomist of his age.

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* Fifth Report to the Alloys Research Committee of the Institution of Mechanical Engineers, 1899.

XIII.—*History and Art: a Florentine Outline.*

BY

JAMES A. MORRIS, I.A., F.R.I.B.A.

[Read before the Architectural Section, 12th March, 1900.]

A KNOWLEDGE of history, like a knowledge of heredity, is one of those silent factors in the world's life, one of those iron keys which opens massive doors into still chambers, wherein strong men may look, and wise men learn.

Real history is the comprehensive and impartial record of the past, and the knowledge of a nation's antecedents is as essential to a right understanding of its present or future, as is a knowledge of heredity to the well-being of the family life; for, possessed of that knowledge, one can the better understand the recurrence or development of hereditary traits in the national or family life, whether of good or ill.

Now the influence of heredity, is, I think, discernible also in the arts; and, in a measure, goes towards the explanation of those recurrent art periods which seem so puzzling to the historian; but, are they not puzzling, just because so many histories are not comprehensive, in the sense that they unfortunately ignore art, or, if it be recognised at all, it is with scant courtesy, and seeming ignorance. The futility of this procedure is made further manifest, when one considers how much historical documents vary in detail, or present only one side of a matter, according as they have been penned by partisans or others; and in seeking justly to apportion these, it is worth while to remember how little we can assure ourselves of the real facts of political or social life, even of to-day; and, if this be so, how much less are we able accurately to discriminate between true and false, in the more uncertain records of the past. Yet, historians seem sometimes willing to rest content with such evidence, presumably for want of better; and all the while they have ready to hand and disregard, incontrovertible facts in Architecture, Sculpture, and Painting, which, rightly interpreted, show more of the real life of a people and of its faith, than all the accredited records and dogmas that ever were formulated. Let an artist study, for instance, the Elgin Marbles, and in the end he will learn from them more of the spirit and culture with which Greek literature is pregnant, and of the Greek himself, than he will ever learn from written history; and it is surely as suicidal to exclude from the pages of history all record of art, as it would be to exclude all literature. Further, all the material creations and surroundings of a people, down even to the meanest kitchen utensil, are of value, as showing how in simple fashion, even the simplest of them lived.

But the history of a nation, even as it is written, is not without use to the student of art; for, interwoven with the rugged prose of the record of its life, he may yet discern the golden thread of beauty, and, if he be only simple enough to hear and see the divine in common life, he may weave of the thread a gorgeous garment, and transmute even dead bones into living flesh by the alchemy of his divine art.

Now, while history, truly written, can record and punctuate the development of art, and register and imprint artistic facts, it is yet but a truism to say that history cannot create, or even teach art; for art, like thought, cometh not with observation, nor by the will of man. None the less, art students may surely learn what history can teach; for, while it is true, that art is beyond the call of man, it yet at many points touches man's inmost life, and is in turn influenced by it; while sometimes even, as with the Etruscans, it remains the most articulate voice of a people, long after the people itself has passed away. In this sense, art surely then shows kinship to history, and history, with art, has at least this in common, that the substructure upon which they both build is "truth;" for, without truth, history is but fable, and art cannot be.

If all this be so, wherein then can history be of use to, or become the exponent of art? History is not, and never can be, in any real sense, the exponent of art; but history can tell of the welding together of the different peoples out of which a nation is formed, it can show something of its remote birth source, of its different strains of blood, and something too, hereditary or superadded, of the faith, thought, life, and work of the race. And while these, in themselves, will not enable us to know the individual artist, they will yet show us something of his race temperament, and possibly thereby help us, by induction, to get closer to the individual man himself, and to better understanding of his work.

These things, I can only imperfectly suggest. I do not seek to teach. I wish only, if I may, to indicate lines of thought, based on historic truth, rather than go again over the well known paths of conventional study; and, by personal inclination at least, seek those pleasant by-ways which lead from every road, for there, I think, one finds the sweetest flowers, the freshest green; and there, at least, one is more alone:—and it is good sometimes to be apart from one's fellows, if only as George Eliot makes gruff old Piero de Cosimo put it that, "we be not choked with other men's thoughts."

Following then the lines of this general introduction, and applying them broadly to the inception and development of Florentine art, we soon reach the incontrovertible fact, that the greatest of all Italian art is Tuscan; and the crowning glory of Tuscan art, the mother and sweet matron of it all, is Florence, "the fair city of lilies."

To know a little then of Florence, and of her people, I propose that we first listen to history; for neither Florence nor her art are of to-day, both are of the past, and in art, Florence is ever a mediæval city, and a city of the Renaissance. But long before even mediæval days, Florence was a place of note. Situated at the confluence of the Arno and Mugnone, enclosed on either side of the long valley by fair hills, and born in a plain of white lilies, she rose like Aphrodite from a sea of white foam; and, although lying somewhat in the northern part of classic Etruria, she was yet cradled upon its only river of importance, the pure blood of the vernal art of Etruria pulsing hotly in her veins; while ancient Fiesole, looking downward from her mountain height, but three miles distant, heard the birth cry of the new city, and was the Etruscan sponsor of the child.

After the Roman conquest, came the deluge of Teuton blood, fierce, determined, strong, and heroic in its denial of defeat; and, to my thinking, the influence of Etruscan refinement, stimulated by the inherent energy and fierce capricious will of the Teuton, moulded and impelled the spirit of Tuscan art. And, note this further, that where Etruscan life and northern blood were strongest, there too, in after days was purest and strongest Italian art; while outwith the boundaries of these two united influences, Italian art was, in comparison, unknown.

Beyond the boundaries of old Etruria, there is, indeed, Rome; but is not Roman art, early perhaps, as well as late, Roman only by virtue of political and ecclesiastical strength and power? Of art, the Rome of the Renaissance had none. Her churches were built and decorated for her by Florentine artists, her pictures painted by them, and her buildings enriched with their sculpture. The architects of Rome's greatest church were almost wholly Florentine, and wholly Tuscan, save only her own son, Maderno, who, by his nave, ruined the spirit of Bramante and Michael Angelo's great design, and so brought unto himself enduring shame.

Neither have Venetian or Lombardic art, the dignity and power of Florentine art, and the former is redolent more of the East than of the West. Giorgione and Titian are sumptuous painters, but different is their art from the serious sweetness of Giotto; the superhuman force and irresistible magnificence of Dante; the solemnity and power of Michael Angelo, in him culminating, in some respects, in his Last Judgment, and the pictured sufferings of the damned. But, although Tuscan art is the most serious of all Italian art—and in this may again be discerned its Etruscan heritage of gloomy religion and solemn awe—it is yet serious only in its deep joy; for its joy, like all lasting joy, is abstruse and grave. Classic dignity and refinement ever became Florence, and one is inclined to think that the source of much of that dignity and refinement, is also to be fouud not remote from its Etruscan origin. The very name of Tuscany itself, is but the continuance of Tusci, or Etrusci; the old word still lingers in the land, and with it much else besides that is of value, more even, than we perhaps surmise. Etruscan power was greatest in the sixth century B.C. In the third century B.C. it became subject to Rome, and Signor Melani holds, that the "architecture of Rome itself was grafted upon Etruscan work, and had acquired a character of its own prior to the exercise of Greek influence." If this conclusion be well established, and it seems one not unreasonable, then it is an opinion to be remembered.

But Etruscan influence, is not the only influence apparent in the moulding of Florentine art, for, it must be remembered, Florence lay also immediately on the direct road from the north to Rome; and, as by this road from the passes in the Carnic Alps, surged in succession those waves of barbaric invaders, whose hosts for centuries overran the land; so in this influx of Teutonic ancestry, we find the second, as I think, of the two great hereditary influences apparent in the moulding of Tuscan art; for the impress of the Teutonic mind and character, is marked unmistakably in the Tuscan people. And in those terrible centuries of coalescence,—for, the "Italian people," it has been well said, "is made up of the people of every nation Rome ever conquered, or that ever conquered Rome;"—in those grim centuries of Roman decay and rottenness, of alternate craft and fighting, when war, pestilence, desolation, and famine, walked with the Goth rampant in the land, the history of Florence, as of Italy, was eventful enough. As early indeed as A.D. 180 the Teuton had measured swords with the Empire, and been worsted; but, on the 9th of August, in the year 378, the old and the young world again tried their strength, and this time the young world prevailed. But Italy was not theirs, nor yet to be, till Alaric had fought and been defeated, and fought again and conquered, in his famous campaigns of 400-415, and then, for the first time, the fair land was laid at the foot of the Goth, and the unflinching hand of the hardy northern race crushed even Rome itself in its terrible grasp.

In persistent succession, host after host of this same northern race, followed on the southward march, each having its own try for the goodly land. In due time, impelled like the others, and having gathered his host from many tribes, came Theodoric, the mighty Ostrogoth, warrior, and ruler; by some accounted founder of Byzantine architecture in Western Europe. Now these Goths were not all wanton destroyers of things beautiful. Theodoric not only built much, but set his face hard also against all destruction, and laboured to preserve such ancient monuments as remained in the land. He was a wise man, and a just ruler; but, as became one of his race and rank, a fighter pre-eminently: and so, on the morning of his great battle he called his mother, who had remained with him in all his wanderings, to bring a bright mantle she had embroidered for him, and put it on over his armour, that all men may see "how he goes gayer into the fight than ever he did into feast," and that she, his mother may see, "whether she have brought a man child into the world or no."

Characteristic surely, is this, of the indomitable spirit possessing these men. Barbarous and untutored in all save war, their religion the weird myths of the austere north, they were yet stout of heart and strong of will; a ruling race. Great men were they, and mighty children; with the credulity and passionate jealousy of the child, intensified and not restrained by the consciousness of power, they were beguiled often to turn their hand, brother against brother, and so work the astute Romans will. Deluded and imposed upon through long years, by the craft and ceremony of the decaying Empire, they yet in the end learned also something of the Roman's power, and so won for themselves the land. Thus, on Easter Tuesday, in the year 568, was Italy once again invaded by the old foe, and for the last time; for the incomers went not away, but stayed, and gave to the northern plains their Lombard name. Through the old passes had they poured into the war-worn land, where none were then strong enough to say them nay. Alboin, once before ranging as young princeling, came again as leader; then seeking adventures, and not much caring with whom he fights, so long as they fight stoutly and well, comes now as conqueror; to remain his time. Ruthless and untractable to the end, Alboin, the mighty warrior and fierce prince, the final founder of the Italian people, died by his own sin. In a fit of drunken revelry, he forced his wife, Rosamund, of fair name at least, and daughter of Cunimund, his early foe, to drink at a great feast, and at his command, a draught of wine from a goblet fashioned from her father's skull. Fierce and barbaric was the deed, and fierce and foul was the revenge; for, by the sin of her own body she achieved her lord's murder, and so herself also passed unto a wicked end.

Now, do we the better understand the seven devils of the Goth, and his desire also to do great deeds, and encompass great ends? Or, do we a few centuries afterwards, recognise in modified form, with chastened temper and controlled will, the spirit which animated the Free Republic cities of Italy; and see also in the blood of a young nation, the source, whence art drew the vitality which made possible the ambition and achievement of the Renaissance?

Contemporaneously with the birth of European national life, Florence rises into the beginning of her greater prominence, filled already with those dim yearnings for that individual freedom she was the first to realise, and in the struggle for the attainment of which she held the first place, even in advance of the rest of Europe. Always the most notable, although not the earliest city of that brilliant period in Italy, Florence issued from the obscurity of her earlier days during the opening years of the eleventh century. With the last days of the previous century, had passed away unfulfilled, the almost universally prevalent belief, that the close of the year 999, would see the end of all things earthly. But as the new century opened, and the years rolled on, and the end came not, the gloom which had gathered, gradually passed away; reviving hope rose anew in men's hearts, fresh activity entered into their lives, and the era of the middle ages was at hand. In all European countries was this influence felt, the mental strain where not deadened was relaxed, and human energy swung back into vigorous national life. The religious fervour in the beginning of the century, induced by the fear of the last day, found expression in the erection of churches and monasteries : the arts received a fresh impulse, and, architecture leading, took a new lease of life, the most brilliant since that of Greece, and flourished in all the great countries of Europe. Already the individual was beginning, unconsciously, to separate himself from the mass, the Church of Rome was entering on her struggle for temporal power, pilgrimage to the Papal city became more frequent, while, at the Holy City of Jerusalem, men believed their sins could be washed away. The crusades followed; the East was again opened to the West, where its influence was felt anew, and Italian commerce enriched her own cities and Europe with its treasures. Pisa and Genoa, among the earliest of the Republic cities, were, with Venice approaching the zenith of their fame. A great art period would soon shed its first rays over the land, and already, above the gray mist of its early morning, were rising, bathed in its roseate light, those many mountain peaks of art, by and by, to focus on themselves its golden beams and cast them back with increasing splendour, till, flashed from point to point with unstinting hand, the whole land should be enveloped in one blaze of art. Florence concentrated on herself the high noon-tide of its beauty, and on the fair city of white lilies, lingered longest its declining rays.

Writing broadly, it may be taken, that from the time of Cimabue (1240-1302) to the close of the sixteenth century, there was little or no divorce between the arts. True, in the fourteenth century, the painters seceded from the Masonic Guild, the Sienese painters in 1355, leading; and the introduction, about that time, of oil as a new medium, caused fresco, till then one of the many branches of the Masonic Guild, gradually to give place to altar, or perhaps even easel pictures; but till later and degenerate days, there was never any hard line of cleavage in art, and it is difficult sometimes to say, whether its followers were pre-eminently architects, sculptors, or painters. Of the training of these men, we have record and tradition; but the source whence came their superabundant inspiration, their exhaustless energy, their unfailing power, is surely to be found in race heredity alone. Simple craftsmen, for the most part they were, and this, most of all perhaps, in the earlier days. Workers in gold and silver, iron, bronze, wood, or stone, their workshops often open to the street; but, whether working beneath the shadow of their own signboard, or in the less generous and more artificial atmosphere of the palaces of their patrons, of this only can we be sure, that in their art they were simple, because natural, and they did their work well, because it was not in them to do otherwise. Curious it is to read the quaint, old-world stories, which have come down to our day, and to learn, in some measure from them, what manner of men they were who laboured and left those works, that are so still and solemn, so far beyond our lesser selves, and our lesser work; exuberating in power of mass and vigour of line, glowing with a wealth of colour, and of colour drawing, to which we cannot attain; with a refinement of detail which we cannot rival, with a sense of bigness, directness, and simplicity, of power and reserve, of the very life and soul of art; these men towered above our heads, their eyes beheld things to which our eyes, save through theirs, are blind, and beside their works our works, are less even than the shadow of their substance.

Think also, of the times in which they lived. Cities vied with one another in arms and proud splendour, bitter feuds were rife, and factions everywhere, but art apparently knew none such; peace-loving folk, its followers, for the most part seem to have been, and we read of none who came to a violent end. From one city to another they passed, welcomed, and required alike by all, and they, careless seemingly whether Guelph or Ghibelline ruled the land. Even the fierce tumult of street fighting, and the enticing charm of a party brawl, seems to have had but small delight for them, and failed to break the gentle tenor of their way;

above whose simple calm, almost alone among artists, rises the proud spirit of Michael Angelo; not, however, to be spent in petty feuds, but raised, as befits a Prince, against the armed might of the Pope himself; and his genius reared those grim Florentine walls, before whose brown heights the armies of Holy-Church, for nearly ten months, were held at bay.

But Pope Clement had need of Michael Angelo, and all men were not so readily forgiven, as was the great artist. Less fortunate indeed, had been the lot of Dante, who, once exiled from his beloved Florence, its gates were never again opened to him in life, or in death: but Dante was a politician before he was a poet; and who knows, save that for the bitterness of the great death that passed over his soul, in his severance from his beloved Florence, and his hopeless exile, the Divine Comedy would ever have been written as it is, if written at all!

When Dante was born in 1265, Cimabue was a young man of twenty-five. Arnolfa, seven years older, was even then probably, working somewhere as a pupil of Niccolo Pisano, perhaps at Pisa, as he certainly was at Siena, three years later; one of a band of journeymen or craftsmen under that great sculptor, then an elderly man of sixty. Fitting it is, to remember the political and social surroundings among which these men worked and lived, and to recall how fiercely bitter were the feuds between Guelph and Ghibelline, not only in Tuscany, but also, and perhaps most keenly, in Florence; for, upon one occasion the city was only preserved from internecine destruction by the noble efforts of the Ghibelline, Farinata degli Uberti, who curbed the mad fury of his victorious party, and, for this, his after time enemy, Dante, commended him, and in Hades his shade utters these noble words:

> "But singly there I stood, when by consent
> Of all, Florence had to the ground been raz'd,
> The one who openly forbade the deed."

Then, when in turn, Guelph had driven out Ghibelline, they refused to allow the Palazzo della Signoria to be built in the centre of their great public square, but only at one side; as, otherwise, then in part its foundations would touch soil upon which had once stood a palace, of the accursed Uberti family. Grim Gothic fierceness enough, this surely!

At this time, 1298, Arnolfa was not only beginning the great municipal palace, but his greater cathedral, and the church of Santa Croce had also been getting themselves built by him, for over four years; and not alone were these, for many another stately edifice was rising throughout the city: and Macchiavelli says:—"Never was the town in a more happy or flourishing condition than at this time, rich in population, treasure, and aspect, having 30,000 armed citizens, and the whole of Tuscany either allied or subject to it." In 1300, Dante was chosen Chief Magistrate. Two years afterwards, he is its ambassador at Rome; and in that same year, he was exiled from Florence.

These, then, were the restless times in which these great buildings were reared, and made rich with frescoes and paintings. Gothic architecture had been transplanted, some hold, to Assisi in 1228, fully equipped from the North by a German named Jacopo: others, that it was in Italy, as in other countries, the logical sequence of architectural development. Whether then, indigenous or not, many churches and cathedrals followed in the new style, each in succession becoming more influenced by the spirit of the land; and these were the buildings enriched by an endless succession of famous artists, each entering upon his own inheritance, till their walls were ablaze with beauty and power. Niccolo Pisano, Cimabue, Arnolfa, and Giotto, were among the giants who built and embellished in Tuscan cities, and made Florence renowned above all others in Italy, for love of, and joy in the arts.

These four men each knew the other, and must have worked at times, the one with the other, in the same building. Dante too, was of them, and it is said visited Giotto at Assisi, and saw his work there fresh and bright, as it came from his hand: certain it is that he got himself painted by Giotto on the walls of the Bargello in Florence, for there his portrait remains to this day. And in the Spanish Chapel of Santa Maria Novello, are painted by Simone Memmi, not only Cimabue, Petrarch, and Boccaccio, but his master Giotto also, and Arnolfa; and with Arnolfa his cathedral, not as it is built, but as he had planned it to be. Madonna Laura too, is there, and these all met often and talked together, and helped, doubtless, the one the other in their work, as do all true artists, of whatever time or country, willingly and with gladness.

Italian sculpture, before Niccolo Pisano, was not only rude, but dead also. This man, however, was strong enough not only to think, but to act also for himself; only, like others, he had first to see, and sight came to him in certain Greek Sarcophagi, brought to Pisa by her commerce; and a diligent study of these opened for him a door into a new world. From labouring at the sculpture of the Pisan Cathedral, he passed to his pulpit in the Baptistery, and eight years afterwards when he was a man of sixty-three, he amplified his design in the pulpit of Siena Cathedral.

As Niccolo changed the spirit of sculpture, so too Cimabue began to overstep the archaic limitations imposed upon painting. Greek influence was again, as with the sculptor, the cause, and Vasari says, Cimabue "achieved little less than the resurrection of painting from the dead." His great picture of the Virgin in the Church of Santa Maria Novello, was carried in solemn procession and with much honour, through the streets of Florence, from the painter's house to the church. Cimabue was a man quick and proud in disposition, and if a work failed to please him he hesitated not to destroy it, no matter how valuable it might be.

And now we come to Arnolfa, a man trained as a sculptor, and achieving renown as an architect. In 1280 the Florentines resolved to build a great church in honour of St. Mary; a church which should surpass in grandeur everything previously erected. Arnolfa was chosen architect, and by his labours therein, as well as in other buildings, architecture màde equal progress with the art of painting under Cimabue, by whom indeed Arnolfa had been instructed in the art of design, as he had also been in the art of sculpture, by Niccolo Pisano, the inaugurator of the revival of that art. Art was now in the ascendency; men gloried and rejoiced in its creations, and between its various forms of expression there was no forced severance; for the men who painted, built also, and embellished their own designs with the work of the sculptor's chisel. Truly this was the golden age of the sculptor architect.

Giotto followed Arnolfa, and completed the quintette in this magnificent brotherhood of art. He raised for him a stage higher the walls of his cathedral, and in the prodigality of his genius planted by its side the fairest lily in all the fair city of Florence. Listen to Ruskin. "The characteristics of power and beauty occur more or less in different buildings, some in one and some in another. But all together, and all in their highest possible relative degrees, they exist, so far as I know, only in one building in the world, the Campanile of Giotto."

Giotto also enriched with his frescoes, almost every church in Florence, and in Santa Croce is to be found perhaps his most valued works; but Rome, Naples, Assisi, Ravenna, Padua, Pisa, Lucca, and Milan, knew him also, and now share in the glory of his name.

Within a period of nine years, and within thirty-five years of Giotto's death were born Brunelleschi, Ghiberti, and Donatello. Brunelleschi who gave to Florence her red heart, that dome so grave and beautiful; Ghiberti who wrot those Baptistery doors, of which Michael Angelo said, they were "worthy to be the gates of Paradise"; Donatello, gentle and sweet of disposition, yet strong enough to bring back sculpture to idealised realism, from the pictorial character Ghiberti was imparting to it. This great triumvirate of art, comprised men who, in their early youth, the eldest just then twenty-four, had competed with others in most gracious spirit for these Baptistery gates, which Ghiberti won. And then, all know the quaintly pathetic story of Brunelleschi's and Donatello's rival crucifixes, and how in the end Donatello generously said to the other, "to thee it is given to make the Christ, to me only the contadini." Brunelleschi's crucifix is now in the church of Santa Maria Novello, and from that crucifix go to his great Pitti palace, sublime too, in simple mass and grandeur, and learn from it the majesty and the power of line. With these men, yet a little later, worked also Luca della Robbia, first trained as were Brunelleschi and Ghiberti, in the art of the goldsmith. Craftsmen, ever and always, were these men; and being craftsmen, they were also great artists.

From Fiesole, the Etruscan mother town, subjugated long years before, came in the divine revenge of love, Fra Angelico, to paint, and Mino da Fiesole, and other of her children, to decorate, and make more beautiful, if possible, than before, this fairest of cities.

Masaccio marks the advance of realism in Italian art, and this not only in the figure, but in drapery and landscape also; and many succeeding artists, Michael Angelo amongst them, studied, and studied most gratefully and carefully, his work in the church of the Carmine. Masaccio gave promise of being one of the greatest masters of his age, but his early death at twenty-seven, forbade its realisation.

The pictures of Botticelli, as also those of Pietro della Francesca, Piero di Cosimo, and others of his more immediate day, are to my mind, so full of dignity and rhythmic composition, that from them one may learn much of the spirit of architecture. Surely this is proof, if proof be needed, that art is one in spirit, that severance therein is impossible;—

save that the end sought, be its death. The grace, not less than the culture, which characterised all his work, are doubtless his own, but the latter must have been much quickened by the noteworthy gatherings at the palace of Lorenzo the Magnificent, wherein met men of the day, famous in art, literature, and science. Botticelli came strongly under the influence of Savonarola, and for that reason gave up altogether his art, espousing instead the cause of the Reformer. Michael Angelo also, came for a time, under the same influence, and I think I have somewhere read, that in consequence thereof, he destroyed many of his drawings.

Of this great man, architect, sculptor, painter, poet, and much else besides, one may not presently write; but I think it is Vasari who has a most interesting paragraph in his book, and one touching a later day, which it may be good for us to consider and lay to heart. Writing of a time shortly before his death, and this was of course long years after Savonarola's martyrdom, we are told that "he burnt a large number of his designs, sketches, and cartoons, that none might see the labours which he had endured, and the trials to which he had subjected his spirit in his resolve not to fall short of perfection."

But time would fail me, and the richness of the names would overpower us, were I to tell you, even if I could, of the great princes of art; of Alberti, Michelozzo, Bramante, of Filippo Lippi, Luca Signorelli, Ghirlandaio, Mantegna, the Bellini, Da Vinci, Raphael, Giorgione, Titian, and a whole firmament of others; of how they laboured and attained in art to human perfection, in much pain, in sore travail and disquiet, with periods of alternating exaltation and despair, as do all artists: despair that is, of ever reaching their own high ideal; and the less selfish, the higher, more noble is that ideal, the better and richer must the work ever be.

And now, to what does all this speaking tend; to what plain, or pinnacle, mountain height, or precipice, does it lead? Surely to this, that each individual man while learning from others, must yet ever be individual also in his own expression of art; and that too, whether it be in continuance of tradition or severance therefrom; just as did these old Florentines, and as does always each true artist, be he great or small. May we not then accept, as the foundation of good work, that a man's art must be his own, and not anothers, no matter how great that other's may be; else will his art surely be, if not a dead, then at best to him but a dying art.

Giotto dared to break away from the accepted teaching of his day, in a simple and inoffensive manner, and in quietly going about his own work, and attending to his own concerns, he revolutionised all succeeding art. Enthusiasm and energy are good, but quiet enthusiasm is ever best of all, and most potent; being without hurry or fear, because born of faith.

In this paper, I have refrained from speaking exclusively of architecture; for architecture is not to be taught by me. Each must learn for himself alone, just as did Brunelleschi, who, from his continual digging about the ruins of Ancient Rome, was called the "treasure seeker." So in like spirit must we, by much patient and careful measuring and study of old buildings, labour if we would excel; following also therein, the footsteps of any of our own day who may have achieved renown. And I would add, see and study such buildings by night as well as by day; and if, perchance, one wanders through some dim aisle, or beneath the arches of a great choir, roofed or unroofed it matters not, when the moonlight fills the whole, and casts deep fantastic shadows, and streams in through traceried window or leaded glass, lighting up to life again some old tomb, till one sees the spirit of the dead clay move, and the place becomes peopled with the life of the past. Then too, from the wind sounds and the quivering moonbeams, playing in mystic fashion on rugged wall or pillar, arch, and pinnacle, then from these will we see and hear also of new forms and colours, and learn from sources little thought of before, that "there are more things in heaven and earth than are dreamt of in your philosophy;" and that art, like the spirit, is divinely born, blowing like the wind where it listeth, none knowing of its coming or going, its times or its seasons.

It is to sources such as these, not visionary, but real, as real as are the material elements, I would urge all to go and learn of architecture, just as much as from sculpture and painting. These things are what I would call the correctives of our work, the things that lift us up a little beyond the level of our daily task; and I know of no better test, than for an architect to go straight from his building—his clay, his metal, his fabric, his colour, from whatsoever labour his hand may find to do,—to go straight to the picture of some early Italian master, to some old-world fane, and having been touched by the spirit of their art, to return again to his work, and see if he be satisfied with what he has there done. And, if I may venture but a word more, I would urge, above all else, that our art be a living art, that it be our own in truth, and not an archæological reproduction, however fine, of anything already achieved. Let "the dead past," in that sense, "bury its dead." Surely it is as true to-day, as it ever was, that "life is more than meat, and body than raiment." Let us seek then to live the life that is natural and true, to know and understand, the life and needs of our own day, the wants of our fellow men, the spirit fashioning our age; then knowing these, but knowing also our art, let us be not afraid to go forward, though none else follow.

RULES GOVERNING THE COMPETITION FOR THE GRAHAM MEDAL.

(Printed by Order of the Council.)

1. The competition for the Graham Medal shall be under the authority and control of the Council of the Philosophical Society of Glasgow, whose decision on all points connected therewith shall be final.

2. Each candidate shall forward to the Secretary of the Philosophical Society of Glasgow, 207 Bath Street, Glasgow, on or before 14th March of the year in which the competition is held, a paper giving an account of an unpublished original research conducted by himself in any branch of chemical science.

3. The medal shall be awarded to the candidate whose research, in the opinion of the Council, or of the person or persons whom they may appoint to adjudicate in the matter, is of the highest merit, and most likely to aid in the advancement of chemical science.

4. The successful candidate shall read the paper, on account of which the medal is awarded, to the Philosophical Society of Glasgow. The paper shall thereafter be published in the *Proceedings* of the Society, and its publication elsewhere shall not take place without the permission of the Council.

5. No award shall be made if, in the opinion of the Council, no candidate has contributed a paper of sufficient merit.

MINUTES OF SESSION.

1899-1900.

1st November, 1899.

The First Ordinary Meeting, for Session 1899-1900, of the Philosophical Society of Glasgow, was held within the Rooms, 207 Bath Street, on the Evening of Wednesday, 1st November, 1899, at Eight o'Clock—Professor Barr, Vice-President, in the Chair.

1. The Minute of Meeting, of date 26th April, 1899, having already been circulated amongst the Members, was held as read, was approved, and was signed by the Chairman.

2. Mr. GILBERT THOMSON, M.A., C.E., President of the Sanitary and Social Economy Section, read a Paper entitled "Sanitation by Compulsion." A discussion followed, in which Dr. Erskine, Dr. Park, Mr. Sinclair, Mr. Barr, Mr. Turnbull, and Professor Barr took part. On the motion of the Chairman, Mr. Thomson was accorded a hearty vote of thanks for his communication.

3. Mr. ANDREW MITCHELL, C.A., and Mr. ROBERT M'LAREN of the Royal Bank, were appointed Auditors of the Treasurer's Books.

4. The following gentlemen were elected Members of the Society :—

1. The Very Rev. R. H. STORY, D.D., Principal of the University of Glasgow. Recommended by Prof. Archd. Barr, Prof. Wm. Smart, and Dr. Freeland Fergus.
2. The Rev. JOHN HUNTER, D.D., 9 University Gardens, Glasgow. Recommended by Prof. Archd. Barr, Prof. Wm. Smart, and Mr. Gilbert Thomson.

3. Thomas Beath Henderson, M.D., 155 Bath Street, Glasgow. Recommended by Dr. Freeland Fergus, Mr. F. T. Barrett, and Mr. N. Macwhannell.

4. John M'Kie, M.B., C.M., Florence Bank, Springburn. Recommended by Dr. Freeland Fergus, Mr. J. Craig Annan, and Mr. John Mann.

5. Walter K. Hunter, M.D., 1 Newton Terrace, Glasgow. Recommended by Dr. A. B. Pollock, Dr. Fullerton, and Dr. Freeland Fergus.

6. Lewis MacLellan, Oil Merchant, 5 Bowmont Gardens. Recommended by Dr. Freeland Fergus, Mr. F. T. Barrett, and Mr. N. Macwhannel.

7. H. F. Stockdale, Secretary, Glasgow and West of Scotland Technical College, Clairinch, Milngavie. Recommended by Dr. Freeland Fergus, Mr. R. Goodwin, and Mr. J. Craig Annan.

8. Anderson Rodger, Glenpark, Port-Glasgow. Recommended by Dr. R. Fullerton, Dr. Freeland Fergus, and Mr. Oswald Fergus.

9. Arthur John Fryers, Architect, 22 Bath Street, Largs. Recommended by Mr. John F. Campbell, Mr. J. M'Kellar, and Dr. Freeland Fergus.

10. Robert T. Napier, Consulting Engineer, 75 Bothwell Street, Glasgow. Recommended by Dr. Freeland Fergus, Mr. G. Handasyde Dick, and Mr. J. Craig Annan.

11. Alexander Miller, Jun., Broomhill, Partick. Recommended by Dr. Freeland Fergus, Dr. S. R. Marshall, and Mr. John F. Campbell.

12. William Roberton, Optician, 209 Sauchiehall Street, Glasgow. Recommended by Mr. John F. Campbell, Dr. Freeland Fergus, and Mr. N. Macwhannell.

13. Robert Rule, Jun., 7 Montgomerie Crescent, Kelvinside, Glasgow. Recommended Prof. Wm. Smart, Mr. J. J. Maclehose, and Mr. Walter W. Galbraith.

14. Hugh Osborne, Merchant, 4 Kew Terrace, Glasgow. Recommended by Mr. Alex. Osborne, Dr. Freeland Fergus, and Mr. Oswald Fergus.

15. William Neilson, Analytical Chemist, 95 Finlay Drive, Dennistoun, Glasgow. Recommended by Dr. Fullerton, Mr. Oswald Fergus, and Dr. Freeland Fergus.

16. William M'Laren, Engineer, 7 Westbank Quadrant, Hillhead. Recommended by Dr. Fullerton, Mr. J. Craig Annan, and Dr. Freeland Fergus.

Report of Council for Session 1898-99.

I. *Meetings.*—The Session 1898-99 was one of unusual activity. In order to overtake the work it was found necessary to hold two Special Meetings in addition to twelve Ordinary Meetings. No fewer than twenty-one communications were made to the Society, being an increase of four over the previous Session.

II.—The *Graham Medal and Lecture Fund* and the *Science Lectures Association Fund* are now under the management of a joint-committee. Last autumn this Committee intimated to the Council that they were in a position to award the Graham Medal if a contribution of sufficient merit were made to the Society, and which otherwise fulfilled the conditions of the Trust. By direction of the Council an advertisement was inserted in the leading scientific journals, and those especially connected with the science of chemistry, but no papers were received. This year again the Council have caused the competition to be advertised. At the request of the Council, Mr. Mann drew up a report on the position of the Trust constituted for the purpose of establishing the Graham Lecture and Medal Fund. Mr. Mann's elaborate report is printed in Volume XXX. of the *Proceedings*. The Science Lecture was again highly successful in every way. It was delivered by Mr. A. A. Campbell Swinton, who took for his subject, "Electric Discharges in Vacuo and the Röntgen Rays."

III. *Sections.—The Architectural Section* had regular meetings throughout the Session, and contributed one communication to the *Proceedings*. Contributions were also received from the *Economic Science*, *Philological*, *Physical*, and *Geographical Sections*. A joint-excursion of this Society and the Geological Society of Glasgow took place to Dumbuck for the purpose of visiting the Crannog there. A full account of this excursion, contributed by Mr. John F. Campbell, is inserted in the recent issue of the *Proceedings* of the Society.

IV. *Proceedings.*—Volume XXX. of the *Proceedings* was issued to members in the month of September. It contains twenty communications as compared with fifteen in the preceding volume.

V. *Membership.*—At the beginning of the Session there 627 Ordinary Members on the roll. During the Session 37 Members were elected, and 1 reinstated from the Suspense List, making a total of 665. Of these, 17 have resigned, 20 have died, 2 have been placed on the Suspense List, and 3 have been struck off the roll for non-payment of subscription, so that at the beginning of Session 1899-1900 there were 623 Ordinary Members on the Society's list. Of the new Members admitted during the Session, 8 qualified themselves as Life Members. There are now 163 Members of that class out of 186 who have so enrolled themselves. The roll now includes 17 Honorary Members, 8 Corresponding Members, and 623 Ordinary Members (Annual and Life), or a total of 654.

VI. *Library.*—Annexed is the Report by the Hon. Librarian, from which it appears that large additions have been made to the Library during the past year.

VII. *Finance.*—The Treasurer's statement for 1898-99 opens with a balance of £54 11s. 11d. due to him, against which there was an investment in railway stock of £47 9s., the remainder at cost, of a larger investment partly sold. The accounts close with £87 11s. 2d. due to the Treasurer, with the same investment standing against it. It is believed that, as usual at the close of the financial year, the Society has practically no other outstanding liability.

Separate statements are given by the Treasurer, as formerly, showing the position of the two funds which the Society holds in trust, viz. :—"The Graham Medal and Lecture Fund" and "The Glasgow Science Lecture Fund," the balances of revenue being £72 12s. 9d. and £11 2s. 1d. respectively.

By Order and in Name of the Council,

(Signed) FREELAND FERGUS,
Honorary Secretary.

REPORT OF THE LIBRARY COMMITTEE.

Your Committee have to report that during the past year, 54 volumes and 18 parts of works were added to the Library by purchase, and 50 volumes, 24 parts and 20 pamphlets were presented.

The periodicals received at the Library number 100, of which 68 are bought and 32 presented.

The Society's *Proceedings* were forwarded to 185 societies and public departments, and 144 volumes and 98 parts were received in exchange.

Altogether, during the year, there have been added to the Library 400 volumes, 140 parts and 20 pamphlets, making an estimated total of 13.529 volumes.

In addition to the large number of works consulted in the Library, 703 books and 696 journals were issued to members during the Session.

Since last report 315 volumes have been bound.

The University of Toronto and the editor of the "The Science of Man," a monthly periodical published in Sydney, were added to the list of exchanges.

As indicated by the Honorary Secretary, the preparation of the new catalogue for the Library is being actively carried on.

In Vol. XXX. of the *Proceedings* there will be found a list of the additions to the Library by purchase up till June, 1899; the titles of the books presented, with the names of the donors; the names of the societies, etc., with which exchanges are effected; and a list of the periodicals received at the Library.

JOHN ROBERTSON, HON. LIBRARIAN,
Convener.

15*th November*, 1899.

The Annual Business Meeting, for Session 1899-1900, of the Philosophical Society of Glasgow, was held within the Rooms, 207 Bath Street, on the Evening of Wednesday, 15th November, 1899, at Eight o'Clock—Professor Barr, Vice-President, in the Chair.

1. The Minute of previous Meeting, of date 1st November, 1899, having been printed in the Billet calling the Meeting, was held as read, was approved, and was signed by the Chairman.

2. The following New Members were duly admitted :—

1. The Very Rev. Principal R. H. Story.
2. The Rev. John Hunter.
3. Dr. Thomas B. Henderson.
4. Dr. John M'Kie.
5. Dr. Walter K. Hunter.
6 Mr. Lewis MacLellan.
7. Mr. H. F. Stockdale.
8. Mr. Anderson Rodger.
9. Mr. Arthur Fryers.
10. Mr. Robert T. Napier.
11. Mr. Alex. Miller.
12. Mr. William Roberton.
13. Mr. Robert Rule, Jun.
14. Mr. Hugh Osborne.
15. Mr. William Neilson.
16. Mr. William M'Laren.

3. The Honorary Secretary, Dr. FREELAND FERGUS, presented the Annual Report of the Council, which was adopted.

4. The Honorary Treasurer, Mr. MANN, presented the Annual Financial Statement, signed by Messrs. Andrew Mitchell, C.A., and Robert M'Laren, Auditors, which, on the motion of the Chairman, was adopted.

5. The Honorary Librarian, Mr. ROBERTSON, in presenting the Library Committee's Annual Report, made reference to the New Catalogue in course of preparation. The Report was adopted, and a vote of thanks accorded to donors of books, etc.

6. Professor W. SMART, retiring Vice-President, proposed Mr. John F. Campbell as his successor. The motion was unanimously agreed to.

7. On the motion of the CHAIRMAN, Mr. John Mann, C.A., Mr. John Robertson, and Dr. Freeland Fergus were unanimously re-elected Honorary Treasurer, Honorary Librarian, and Honorary Secretary, respectively, and a vote of thanks for their past services was accorded to them.

Dr.

ABSTRACT OF HONORARY TREASURER'S

And Comparison with

			1898-99.	1897-98.
			£ s. d.	£ s. d.
To Balance from last year— Investment, Caledonian Railway £110, 3 per cent. Preferred, Converted, - - - - - -			47 9 0	47 9 0
,, Subscriptions to 31st October, 1899—				
37 Entry-moneys of 1898-99 at 21s., -		£38 17 0		
Annual Dues at 21s.—				
Arrears, - - - - -	£3 3 0			
For 1898-99, 436 Ordinary Members, - - -	457 16 0			
,, ,, 29 New Members,	30 9 0			
		491 8 0		
Life Subscriptions at £10 10s.—				
1 Old Member,- - -	£10 10 0			
8 New Members, - -	84 0 0			
		94 10 0		
			624 15 0	632 2 0
,, Dividends on Investment—				
Caledonian Railway, April, 1899, less tax,		£1 11 11		
,, ,, Oct., ,, ,,		1 11 11		
			3 3 10	3 3 10
,, General Receipts—				
Bank Interest, - - - - - -		£2 14 5		
Proceedings, etc., sold, - - -		0 12 6		
			3 6 11	3 0 6
,, Legacy by the late Sir Michael Connal— Fourth Instalment, less duty, - - - - -			0 0 0	1 2 6
,, Architectural Section— 86 Associates' fees at 5s., - - - - - - -			21 10 0	19 5 0
,, Economic Science Section— 13 Associates' fees at 5s., - - - - - - -			3 5 0	2 15 0
,, Geographical and Ethnological Section— 13 Associates' fees at 5s., - - - - - -			0 0 0	3 5 0
,, Philological Section—				
3 Associates' fees at 5s., - - - -		£0 15 0		
Subscriptions for purchase of Phonograph,		13 0 0		
			13 15 0	0 0 0
,, Balance due to Treasurer, - - - - - - -			87 11 2	54 11 11
			804 15 11	766 14 9

Memo.—The Society's Investments are—

(1) Bath Street Joint Buildings, as in last Account, - - - -	£3,933 7 4½
Less Society's part of £1,700 remaining on Bond, -	1,200 0 0
	£2,733 7 4½
(2) Caledonian Railway Stock, as above, - - - - - -	47 9 0
	£2,780 16 4½

ACCOUNT—SESSION 1898-99 *Cr.*
Session 1897-98.

				1898-99.			1897-98.		
				£	S.	D.	£	S.	D.
By BALANCE from last year—due to Treasurer, - - - -				54	11	11	71	13	0
,, GENERAL EXPENDITURE, to 31st October, 1899—									
Ex-Secretary's retiring Allowance, - -	£40	0	0						
Salary to Secretary's Assistant, - -	50	0	0						
Allowance for Treasurer's Clerks, - -	15	0	0						
Commission to Collector, - - -	6	15	6						
				111	15	6	149	18	0
New Books & Periodicals, British & Foreign,	£103	8	11						
Bookbinding, - - - - - -	19	5	11						
Printing Circulars, *Proceedings*, etc., -	237	12	11						
Blocks, Lithographs, etc., for *Proceedings*, etc., - - - - - - - -	15	15	9						
Postage and delivery of Circulars, Letters, etc.,	31	2	9						
Stationery, etc., - - - - - -	6	1	5						
				413	7	8	354	14	5
Fire Insurance on Library for £5,400, -	£6	3	6						
Postages, etc., per Secretaries, £3 6s. 5d.; per Treasurer, £2 6s. 7d., - - -	5	13	0						
				11	16	6	13	0	4½
,, Joint Expenses of Rooms—Society's half of £293 9s. 4d., being Insurance, Taxes, Cleaning, Repairs, Lighting, and Heating; Salaries of Curator and Assistant, and its proportion of Interest on Bond, £34 16s.; less half of £87 10s., Revenue from Letting, - -				137	15	8	112	16	0½
,, SUBSCRIPTIONS TO SOCIETIES—									
Ray Society, 1898, - - - - -	£1	1	0						
Palæontographical Society, 1898, -	1	1	0						
				2	2	0	2	2	0
,, SANITARY AND SOCIAL ECONOMY SECTION— Expenses per Treasurer of Section, - - - - -				0	0	0	0	0	0
,, ARCHITECTURAL SECTION— Expenses per Treasurer of Section, - - - - -				12	8	6	11	11	8
,, ECONOMIC SCIENCE SECTION— Expenses per Treasurer and Secretary of Section, -				5	1	11	1	1	3
,, GEOGRAPHICAL AND ETHNOLOGICAL SECTION— Expenses per Treasurer of Section, 18s.; Printing, 12s., - - - - - - - - - - -				0	0	0	1	10	0
,, PHILOLOGICAL SECTION—									
Printing, - - - - - - - - .	£1	8	3						
Expenses, per Treasurer of Section, -	0	1	0						
Phonograph and Cylinders, - -	6	18	0						
				8	7	3	0	19	0
,, BALANCE OF— Investment—Caledonian Railway £110 3 per cent. Preferred, Converted, - - - - -				47	9	0	47	9	0
				804	15	11	766	14	9

GLASGOW, *9th November, 1899.*—We, the Auditors appointed by the Society to examine the Treasurer's Accounts for the year 1898-99, have examined the same, of which the above is an Abstract, and have found them correct, the Balance due to Treasurer being Eighty-seven Pounds Eleven Shillings and Twopence Sterling.

(Signed) ANDREW MITCHELL, C.A.
ROBERT M'LAREN.

JNO. MANN, C.A., *Honorary Treasurer.*

GRAHAM MEDAL AND LECTURE FUND.

Dr. ABSTRACT OF TREASURER'S ACCOUNT—SESSION 1898-99. Cr.

Dr.		
Capital at 1st November, 1898—		
Glasgow and South-Western Railway, Co. 4°/o Preference Stock in name of the Philosophical Society, in Trust,	£250 0 0	
Value of Die at H.M. Mint,	18 18 0	
		£268 18 0
Cash in Bank,		64 15 11
Revenue—		
Dividend, April, 1899, less Tax,	£4 16 8	
,, Oct., ,, ,,	4 16 8	
Interest from Bank,	1 6 6	
		10 19 10
		£344 13 9

Cr.		
Capital at 31st October, 1899—		
Investment, *per contra*,	£250 0 0	
Die,	18 18 0	
		£268 18 0
Advertising in Technical Journals, Competition for Medals,		3 3 0
Balance, being Revenue—		
In Bank, on Deposit Receipt,	£74 19 3	
Less due to Treasurer,	2 6 6	
		72 12 9
		£344 13 9

Glasgow, 9th November, 1899.—Examined and found correct.

(Signed) ANDREW MITCHELL, C.A.
ROBERT M'LAREN.

JNO. MANN, C.A., *Honorary Treasurer.*

THE SCIENCE LECTURES ASSOCIATION FUND.

ABSTRACT OF TREASURER'S ACCOUNT—SESSION 1898-99.

Dr.

Capital at 1st November, 1898—		
£200 Caledonian Railway Company 4% Preference Stock, No. 1, in name of the Philosophical Society, in Trust, cost,	£244 4 8	
On Deposit Receipt,	8 5 4	£252 10 0
Cash in Bank (Revenue),		34 18 6
Revenue—		
Dividend, April, 1899, less Tax,	£3 17 4	
" Oct., " "	3 17 4	
Interest from Bank,	0 12 1	8 6 9
Tickets sold for Lecture,		7 13 7
		£303 8 10

Cr.

Capital at 31st October, 1899—		
Investment, *per contra*,	£244 4 8	
In Bank, on Deposit Receipt,	8 5 4	£252 10 0
Expenditure—		
Honorarium and Expenses for Lecture on 1st March, 1899, on "Electric Discharges *in vacuo* and the Röntgen Rays," by Mr. A. A. Campbell Swinton,		39 16 9
Balance, being Revenue—		
In Bank, on Deposit Receipt,		11 2 1
		£303 8 10

Glasgow, 9th November, 1899.—Examined and found correct.

(Signed) ANDREW MITCHELL, C.A.
ROBERT M'LAREN.

JNO. MANN, C.A., *Honorary Treasurer.*

8. On the motion of Mr. W. W. Blackie, Professor W. Smart, Professor E. J. Mills, Professor G. F. Scott Elliot, and Mr. Robert Goodwin were unanimously elected Members of Council. The motion was agreed to.

9. On the motion of Dr. Fergus, the election of Professor Glaister to the Membership of Council, in room of Mr. Gilbert Thomson, was confirmed.

10. Dr. Fergus moved, on behalf of the Secretary of the Geographical and Ethnological Section, that Mr. W. Ewing and Mr. Robert Blyth be appointed President and Vice-President respectively of the Section; that Mr. Sam. Mavor be elected to its Council; and that Dr. Robert Fullerton be continued in the offices of Hon. Secretary and Treasurer of the Section. This was agreed to.

11. It was moved by Professor Glaister, and agreed to, that the following be elected Office-Bearers of the Sanitary and Social Economy Section:—

President—Mr. Gilbert Thomson, M.A., C.E.

Vice-Presidents— Sir Charles Cameron, Bart., M.D., LL.D.
A. K. Chalmers, M.D., D.P.H.(Camb.).

Members of Council.

Mr. Wm. Key.
Mr. D. M. Alexander.
Mr. D. W. Buchan.
Dr. James K. Kelly.
Professor Glaister.
Dr. R. Stevenson.
Dr. Ebenezer Duncan.
Mr. John Shanks.
Mr. W. Rattray.
Mr. N. Macwhannel.

Mr. Wm. Buchanan, *Hon. Secretary.*

12. On the Motion of Mr. R. F. Muirhead, the following were elected Office-Bearers of the Mathematical and Physical Section:—

President—Professor Magnus Maclean, D.Sc., M.A., F.R.S.E.

Vice-Presidents— Henry Dyer, D.Sc., M.A., C.E.
Professor Andrew Gray, LL.D., F.R.S.

Hon. Secretary and Treasurer—Mr. R. F. Muirhead, M.A., B.Sc.

Members of Council.

Mr. A. J. G. Barclay, M.A.
Prof. Jas. Blyth, M.A., F.R.S.E.
Mr. H. S. Carslaw, M.A., D.Sc.
Professor W. Jack, LL.D.
Mr. A. V. Lothian, M.A., B.Sc.
Mr. H. A. Mavor, M.I.E.E.
Mr. J. D. Cormack, B.Sc.
Professor W. H. Watkinson.
D. S. Macnair, Ph.D.

13.—On the motion of Mr. Lamond, it was agreed that the following be elected Office-Bearers of the Economic Science Section:—

President—Mr. John Mann, Jun., M.A., C.A.
Vice-Presidents—{ Professor Wm. Smart, LL.D.
Mr. Walter W. Blackie, B.Sc.
Honorary Secretary—Mr. Robert Lamond, LL.B.
Honorary Treasurer—Mr. Duncan Mackenzie.

Members of Council.

* Mr. John A. Todd, B.L.
* Mr. Thomas Jones.
Bailie D. M. Stevenson.
Mr. James F. Martin.
Mr. R. W. Cooke-Taylor.
Mr. G. Handasyde Dick.
Mr. Alex. Macindoe.

14. Mr. Clark proposed the following as Office-Bearers of the Philological Section:—

President—James Colville, M.A., D.Sc.
Hon. Secretary and Treasurer—Mr. John Clark, M.A.

Members of Council.

Dr. Annandale.
Mr. F. J. Amours, B.A.
Mr. J. F. Campbell.
Mr. D. H. Crawford, M.A.
Mr. David Lamb.
Mr. Alex. M'Donald, M.A.
Mr. George Neilson.
Mr. Hector Rey, B.L., B.Sc.

15. On the motion of Mr. Mann, a cordial vote of thanks was accorded to the Auditors, Mr. Andrew Mitchell, C.A.; and Mr. Robert M'Laren.

16. William Smart, Esq., M.A.. D.Phil., LL.D., Adam Smith Professor of Political Economy in the University of Glasgow, read a Paper entitled, "The Theory of Taxation."

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* Retire by rotation in 1900.

An animated discussion took place, in which Bailie Ferguson, ex-Bailie Burt, Mr. Alex. Cross, M.P., Mr. M'Lardy, Mr. Mackenzie, and Mr. Hamilton took part.

On the motion of the CHAIRMAN, a hearty vote of thanks was accorded to Professor Smart for his Paper.

17. The CHAIRMAN intimated that the following Gentlemen had been elected Members of the Society:—

1. ANDREW GRAY, LL.D., F.R.S., Professor of Natural Philosophy in Glasgow University. Recommended by Prof. Barr, Mr. R. F. Muirhead, and Prof. Ferguson.

2. WILLIAM ROBERT JACK, M.D., 43 Lansdowne Crescent. Recommended by Prof. Barr, Mr. J. D. Cormack, and Dr. Fergus.

3. JOHN ADAMS, M.A., B.Sc., Rector, F.C. Training College, Glasgow, 12 Holyrood Crescent. Recommended by Dr. Colville, Mr. A. V. Lothian, and Mr. John Robertson.

4. ANDREW E. SCOUGAL, M.A., H.M. Chief Inspector of Schools, 14 Kelvin Drive, Kelvinside, N. Recommended by Prof. Barr, Mr. Benjamin Taylor, and Dr. Fergus.

5. ROBERT MUIR, M.D., F.R.C.P.E., Professor of Pathology in Glasgow University, 4 Alfred Terrace, Hillhead. Recommended by Prof. Barr, Prof. Bower, and Prof. Ferguson.

6. JOHN COCHRANE SHANKS, Sanitary Engineer, 26 West Nile Street. Recommended by Mr. Gilbert Thomson, Mr. W. Forrest Salmon, and Dr. Fergus.

7. WILLIAM W. WATSON, Electrician, 5 Westbourne Terrace. Recommended by Dr. John Macintyre, Prof. Blyth, and Mr. Archibald Watson.

8. JAMES CHISHOLM, Iron Tube Manufacturer, 16 Knowe Terrace, Pollokshields. Recommended by Mr. Robert Graham, Mr. James Deas, and Mr. Bilsland.

9. EDWIN TEMPLE, B.A. (Cantab.), Rector of Glasgow Academy. Recommended by Dr. Blackie, Dr. Fergus, and Mr. Oswald Fergus.

10. W. R. LANG, D.Sc., 9 Crown Gardens, Glasgow. Recommended by Prof. Ferguson, Prof. Barr, and Mr. John Mann.

11. W. G. AIKMAN, 12 Kingsborough Gardens, Kelvinside. Recommended by Mr. J. Robertson Blackie, Mr. W. W. Blackie, and Mr. William Ewing.

29th November, 1899.

The Second Ordinary Meeting of the Philosophical Society of Glasgow, for Session 1899-1900, was held in the Rooms of the Society, 207 Bath Street, on the Evening of Wednesday, 29th November, 1899, at Eight o'clock—Mr. John F. Campbell, Vice-President, occupied the Chair.

1. The Minute of previous Meeting, of date 15th November, 1899, having been printed in the Billet calling the Meeting, was held as read, was approved, and was signed by the Chairman.

2. The following New Members were duly admitted :—

1. Prof. Andrew Gray.
2. Dr. William Robert Jack.
3. Mr. John Adams.
4. Mr. Andrew E. Scougal.
5. Prof. Robert Muir.
6. Mr. John Cochrane Shanks.
7. Mr. William W. Watson.
8. Mr. James Chisholm.
9. Mr. Edwin Temple.
10. Dr. W. R. Lang.
11. Mr. W. G. Aikman.

3. Professor G. F. Scott Elliot, M.A., B.Sc., F.L.S., F.R.G.S., delivered a lecture, with lantern illustrations, on "South Africa and the Present Struggle for Supremacy." On the motion of the Chairman, a hearty vote of thanks was accorded to Professor Elliot for his lecture.

4. The Honorary Secretary intimated that Professor Richard Lodge, of Edinburgh University, who was recommended by the Council, had been unanimously elected a Corresponding Member of the Society; and that the following gentlemen had been duly elected Ordinary Members :—

1. Archibald M'Millan, Merchant, Invermay, Balshagray, Partick. Recommended by Dr. Duncan, Dr. Jenkins, and Dr. Fergus.
2. Thomas Kay, M.B., C.M., 5 Rosebery Street. Recommended by Dr. Fergus, Professor Henderson, and Principal M'Lean.
3. Daniel Douglas M'Dougall, Merchant, 2 Kingsborough Gardens, Kelvinside. Recommended by Mr. W. K. Hunter, Dr. Fergus, and Mr. J. Robertson.
4. William Ramsay, Manufacturer, 146 Blythswood Drive, Glasgow. Recommended by Mr. W. A. Galbraith, Mr. John Mann, and Mr. R. F. Muirhead.
5. Robert Stewart, Property Agent, Newark, Partick. Recommended by Mr. F. T. Barrett, Professor Barr, and Mr. J. F. Campbell.

13th December, 1899.

The Third Ordinary Meeting of the Philosophical Society of Glasgow, for Session 1899-1900, was held in the Rooms of the Society, 207 Bath Street, on the Evening of Wednesday, 13th December, 1899, at Eight o'clock—Professor Barr, Vice-President occupied the Chair.

1. The Minute of previous Meeting, of date 29th November, 1899, having been printed in the Billet calling the Meeting, was held as read, was approved, and was signed by the Chairman.

2. The New Members elected at the previous Meeting were duly admitted.

3. On the motion of the Hon. Secretary, the Standing Orders were suspended, and a vote of condolence to the widow and family of the late Mr. E. C. C. Stanford passed.

It was also agreed that the Hon. Secretary be instructed to send a letter to Mrs. Stanford expressing the sympathy of the Society with her and her family in their recent bereavement; and that it be remitted to the Council to have a short memorial notice of the late Mr. Stanford prepared and submitted to the Society at an early date.

4. In the absence of the author, Dr. Colville read a paper by Dr. Rorie, of Lochgelly, entitled, "Vernacular Names for Popular Ailments." A discussion followed, in which Professor Blyth, Professor Glaister, and Dr. Colville took part. On the motion of the Chairman, a vote of thanks was accorded to Dr. Rorie and to Dr. Colville.

5. Professor James Blyth read a paper on "Some Experiments with Coherers." A discussion followed, in which Mr. Sayers, Dr. Park, Mr. Campbell, and Professor Barr took part. A vote of thanks to Professor Blyth was accorded on the motion of the Chairman.

6. The Chairman intimated that the following gentlemen had been elected Members of the Society:—

1. LEANDER M. FYFE, F.E.I.S., Headmaster, Queen's Park School, Glasgow. Recommended by Dr. Watson, Mr. Robertson, and Mr. Mann.

2. **James W. Peck**, M.A., Arnott Demonstrator in Natural Philosophy, Glasgow University, Broomhill Farm House, Partick. Recommended by Professor Blyth, Principal M'Lean, and Professor Elliot.

3. **Walter Stewart**, Jun., M.A., B.Sc., Chief Assistant to the Professor of Natural Philosophy, Glasgow University, Gartsherrie, Coatbridge. Recommended by Professor Blyth, Professor Mills, and Mr. John F. Campbell.

4. **W. A. Foster**, St. Catherines, Newlands Road, Langside. Recommended by Dr. Watson, Mr. Mann, and Mr. Robertson.

5. **Alfred A. Young**, M.A., M.B., 10 Hamilton Park Terrace. Recommended by Dr. Fergus, Mr. Robertson, and Mr. Mann.

6. **William L. Burton**, Electrical Engineer, 6 Richmond Crescent, Glasgow. Recommended by Mr. David Reid, Mr. John Turpie, and Mr. James Kean.

10*th January*, 1900.

The Fourth Ordinary Meeting of the Philosophical Society of Glasgow, for Session 1899-1900, was held in the Rooms of the Society, 207 Bath Street, on the Evening of Wednesday, 10th January, 1900, at Eight o'clock—Professor Barr, Vice-President occupied the Chair.

1. The Minute of previous Meeting, of date 13th December, 1899, having been printed in the Billet calling the Meeting, was held as read, was approved, and was signed by the Chairman.

2. The New Members elected at the previous Meeting were duly admitted.

3. The Hon. Secretary read a letter he had, by instruction of the previous Meeting, sent to Mrs. Stanford, and also the reply.

4. Professor G. G. Henderson read a Biographical Sketch of the late E. C. C. Stanford, F.C.S., written by request of the Council of the Society.

Dr. Henderson was accorded a vote of thanks on the motion of the Chairman.

5. Contribution from the Mathematical and Physical Section.

Mr. G. Campbell Dickson, A.G.T.C., read a paper on "The Electrical Deposition of Copper, as affected by—(*a*) Density of

Solution; (*b*) Addition, or not, of 0·5 per cent. of Sulphuric Acid; (*c*) Current Density; (*d*) Temperature of Electrolyte."

Mr. Dickson also made two short communications with exhibits, to the Meeting, one on Fulgurites found in South Africa, and the other on a Marine Deposit in Table Bay, Cape Colony.

The discussions on the papers were taken part in by Professor Barr, Professor Maclean, Professor Henderson, Mr. H. W. Christie, and Mr. Campbell.

On the motion of the Chairman, a vote of thanks was accorded to Mr. Dickson.

24th January, 1900.

The Fifth Ordinary Meeting of the Philosophical Society of Glasgow, for Session 1899-1900, was held in the Rooms of the Society, 207 Bath Street, on the Evening of Wednesday, 24th January, 1900, at Eight o'clock—Professor Barr, Vice-President, occupied the Chair.

1. The Minute of previous Meeting, of date 10th January, 1900, having been printed in the Billet calling the Meeting, was held as read, was approved, and was signed by the Chairman.

2. The Very Rev. Principal Story, who was present, signed the Membership Roll.

3. At the request of Professor Barr, who was to open a discussion, Mr. John F. Campbell, Vice-President, here took the Chair.

4. Professor Barr delivered the Opening Address in a discussion on "The Teaching of Arithmetic," in which part was taken by Mr. John Dansken, Professor Gray, Mr. H. Mavor, Professor Mills, Mr. Cowen, Professor Glaister, Mr. James Gibson, and Mr. Donald.

Professor Barr closed the discussion, and was accorded a vote of thanks on the motion of the Chairman.

5. The Chairman intimated that Mr. John C. Hutcheson, Ironfounder, 8 Lansdowne Crescent, had been duly elected a Member of the Society, on the recommendation of Dr. M'Millan, Professor Henderson, and Dr. Fergus.

7th February, 1900.

The Sixth Ordinary Meeting of the Philosophical Society of Glasgow, for Session 1899-1900, was held in the Rooms of the Society, 207 Bath Street, on the Evening of Wednesday, 7th February, 1900, at Eight o'clock—Professor Barr, Vice-President, occupied the Chair.

1. The Minute of previous Meeting, of date 24th January, 1900, having been printed in the Billet calling the Meeting, was held as read, was approved, and was signed by the Chairman.

2. Mr. John C. Hutcheson was admitted to the Membership of the Society.

3. Dr. Robert Fullerton, Hon. Secretary of the Geographical Section, moved—"That the Meeting records, with great regret, the death of Dr. George A. Turner, who was for a number of years, and until recently, President of the Geographical and Ethnological Section of the Philosophical Society of Glasgow. It directs the Hon. Secretary to convey to Mrs. Turner and her family an expression of deep sympathy, and requests the Council to have a memorial notice of Dr. Turner prepared and read to the Society at an early date." The motion was unanimously agreed to.

4. The Chairman explained to the Meeting that Mr. R. W. Cooke-Taylor, who was to have read a paper on "The History and Philosophy of the Factory System," had been suddenly called away on pressing business; but that Mr. Sam. Mavor, as had been notified to Members, had at once consented, when the matter was put before him, to read a Paper then which had been fixed for a later date.

5. Sam. Mavor, Esq., F.R.G.S., described "A Pilgrimage to Solovetsk," the Russian Island Monastery in the White Sea. A large number of lantern slides, from photographs taken by Mr. Mavor, were shown in illustration of the lecture. Mr. Barrett, Mr. Campbell, and Dr. Fullerton took part in a short discussion which followed.

The Chairman, in moving a vote of thanks, said that the Meeting was indebted to Mr. Mavor not only for a very instructive and interesting lecture, but also for the inconvenience the Lecturer had put himself to in coming specially from Belfast to oblige them. The Meeting heartily responded.

6. The Chairman announced that the following gentlemen had been elected Members of the Society:—

(1) **Hugh Galt**, M.B., C.M., F.F.P.S.G., D.P.H.(Camb.), 14 Berkeley Terrace, W. Recommended by Professor Glaister, Dr. Fergus, and Professor Blyth.

(2) **Samuel M. Thomson**, M.A., 208 West George Street. Recommended by Mr. John Mann, Professor Henderson, and Dr. Fergus.

7. The Chairman also intimated that Members of the Society were invited by the Council of the British Astronomical Association to a lecture by Professor Knott on "Some Properties of the Ether, the Vehicle of Light," with experiments, which was to take place in the Society's Rooms on the 16th inst.

21st February, 1900.

The Seventh Ordinary Meeting of the Philosophical Society of Glasgow, for Session 1899-1900, was held in the Rooms of the Society, 207 Bath Street, on the Evening of Wednesday, 21st February, 1900, at Eight o'clock. Mr. John F. Campbell, Vice-President, occupied the Chair.

1. The Minute of the previous Meeting, of date 7th February, 1900, having been printed in the Billet calling the Meeting, was held as read, was approved, and was signed by the Chairman.

2. The New Members elected at the previous Meeting were duly admitted.

3. The Hon. Secretary read a letter which he had written to Mrs. Turner, by desire of the previous Meeting, and also the reply he had received.

4. As the Paper to be read was a contribution from the Economic Science Section, Mr. Campbell here left the Chair, which was thereafter occupied by Mr. John Mann, Junr., M.A., C.A., President of the Section.

5. R. Whately Cooke-Taylor, Esq., F.S.S., F.R.Hist.S., H.M., Superintending Inspector of Factories for Scotland and Ireland, read a Paper, entitled—"The History and Philosophy of the Factory System." A discussion followed in which part was taken by Prof. Smart, Miss Irwin, Dr. Park, Mr. Berkeley, Miss Mathieu, Dr. Dyer, Mr. Arneil, and the Chairman.

Mr. Cooke-Taylor replied, and was accorded a vote of thanks on the motion of the Chairman.

7th March, 1900.

The Eighth Ordinary Meeting of the Philosophical Society of Glasgow, for Session 1899-1900, was held in the Rooms of the Society, 207 Bath Street, on the Evening of Wednesday, 7th March, 1900, at Eight o'clock. Mr. John F. Campbell, Vice-President, occupied the Chair.

1. The Minute of the previous Meeting, of date 21st February, 1900, having been printed in the Billet calling the Meeting, was held as read, was approved, and was signed by the Chairman.

2. Dr. Robert Fullerton, Hon. Secretary of the Geographical Section, read a Memorial Notice of the late Dr. George A. Turner.

3. Professor Edmund J. Mills, D.Sc., F.R.S., read a Paper on "The Relation of the Ash to the Heights of Plants," with Lantern Illustrations. Dr. Mills exhibited the apparatus used in making his determinations, and also his "Artiograph," an instrument for facilitating the smoothing of experimental curves.

4. Mr. Vincent J. Blyth, M.A., read a Paper on "The Thermal Conductivity of Substances of Low Conductivity," being a contribution from the Mathematical and Physical Section. Mr. Blyth showed the apparatus and the arrangement of it used in making the series of experiments described in his Paper.

5. Mr. David Robertson, B.Sc., A.G.T.C., read a Paper on "The Equilibrium of a Column of Air, and the Atmospheric Temperature Gradient," illustrated with Diagrams and Lantern Slides.

On the motion of the Chairman a vote of thanks was accorded to each of the above gentlemen.

21st March, 1900.

The Ninth Ordinary Meeting of the Philosophical Society of Glasgow, for Session 1899-1900, was held in the Rooms of the Society, 207 Bath Street, on the Evening of Wednesday, 21st March, 1900, at Eight o'clock. Mr. John F. Campbell, Vice-President, occupied the Chair.

1. The Minute of the previous Meeting, of date 7th March, 1900, having been printed in the Billet calling the Meeting, was held as read, was approved, and was signed by the Chairman.

2. The Paper to be read being a contribution from the Philological Section, Mr. Campbell here left the Chair, which was taken by Dr. Colville, President of the Section.

3. Mr. D. T. Holmes, B.A., read a Paper entitled "The Vernacular Poems of Robert Fergusson."

Considerable discussion followed in which part was borne by Dr. Colville, Mr. Clark, Mr. J. Forbes Ferguson, and Mr. Shannan.

Mr. Holmes replied, and was accorded a vote of thanks on the motion of the Chairman.

4. Mr. John F. Campbell intimated that at the next Meeting, the Graham Lecture would be delivered by the Master of the Mint, Sir W. Roberts-Austen. The title of the lecture would be given on the Billet, but the subject would be some special application of electricity—probably in connection with electric fusion, or alloys, on which the Lecturer had made many original researches.

4th April, 1900.

The Tenth Ordinary Meeting of the Philosophical Society of Glasgow, for Session 1899-1900, was held in the Rooms of the Society, 207 Bath Street, on the Evening of Wednesday, 4th April, 1900, at Eight o'clock. Mr. John F. Campbell, Vice-President, occupied the Chair.

1. The Minute of the previous Meeting, of date 21st March, 1900, having been printed in the Billet calling the Meeting, was held as read, was approved, and was signed by the Chairman.

2. The Chairman explained to the Meeting that, as intimated to Members by special circular, Sir W. Roberts-Austen was unable, through illness, to lecture that evening, but that instead, Professor Glaister would read the Paper promised for the 18th inst. They were much indebted, he said, to Professor Glaister's kindness for having, on the shortest notice, and at great personal inconvenience, altered his holiday arrangements to stay in town for the purpose of reading his Paper to the Meeting.

3. Professor John Glaister, M.D., D.P.H., read a Paper, entitled "The Criminal Codes of the Jews and other Ancient Nations."

A discussion followed, in which Professor Robertson and Mr. Buchanan took part. Professor Glaister replied.

A vote of thanks was accorded to Professor Glaister on the motion of the Chairman.

4. The Chairman announced that the Graham Lecture would probably take place on the 18th inst., and the conditions for admission would be as stated in the previous Billet.

18*th April*, 1900.

The Eleventh Ordinary Meeting of the Philosophical Society of Glasgow, for Session 1899-1900, was held in the Rooms of the Society, 207 Bath Street, on the evening of Wednesday, 18th April, 1900, at Eight o'clock. Professor Barr, Vice-President, occupied the Chair.

1. The Minute of the previous Meeting, of date 4th April, 1900, having been printed in the Billet calling the Meeting, was held as read, was approved, and was signed by the Chairman.

2. The Chairman intimated an apology for absence from the President of the Society, Lord Blythswood, and read a letter from Lord Kelvin expressing regret that he was not able to be present at Sir W. Roberts-Austen's lecture.

3. The Chairman in introducing the Lecturer, Sir W. Roberts-Austen, referred to the fact that the Graham Lecture had been delivered to the Society by the same gentleman several years ago.

4. Professor Sir W. Roberts-Austen, then delivered a lecture under the auspices of the Graham Trust, the subject chosen being "Molecular Unrest in Solids." The lecture was illustrated by numerous experiments.

5. Professor Sexton expressed his gratification at being privileged to be present at a lecture so able and interesting.

6. The Chairman also spoke in highly appreciative terms of Sir W. Roberts-Austen's lecture, and the magnificent experiments which accompanied it. On his motion a hearty vote of thanks was accorded to the Lecturer.

Sir W. Roberts-Austen briefly replied.

7. The Chairman was authorised by the Meeting to sign this Minute when engrossed in the Minute-book.

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Bristol Naturalists' Society. Dr. C. K. Rudge, Ashgrove House, 145 White Ladies' Road, Clifton.

Cambridge—

Philosophical Society, New Museum.
University Library. The Curator.

Cardiff—

Cardiff Naturalists' Society, 44 Loudoun Square.
South Wales, Institute of Engineers, Park Place.

Falmouth—

Royal Cornwall Polytechnic Society.

Greenwich—

Royal Observatory. The Astronomer Royal.

Leicester—

Leicester Literary and Philosophical Society.

Liverpool—

Geological Society, Royal Institution, Colquitt Street.
Historic Society of Lancashire and Cheshire, Royal Institution.
Literary and Philosophical Society. Tate Librarian, University College.
Liverpool Engineering Society, Royal Institution, Colquitt Street.

London—

Anthropological Institute, 3 Hanover Square.
British Association for the Advancement of Science, Burlington House.
British Museum. The Superintendent, Copyright Office.
British Refrigeration Review, 101 Leadenhall Street, E.C.
Chemical Society, Burlington House.
Feilden Publishing Co., Temple Chambers, Embankment.
India-rubber and Gutta-percha and Electrical Trades Journal, 19 Wilson Street, E.C.
Institution of Civil Engineers, 25 Great George Street, Westminster.
Institution of Junior Engineers, 47 Fentiman Road, Clapham Road.
Institution of Mechanical Engineers, Storey's Gate, St. James' Park. Westminster.
Middlesex Hospital, Berners Street.
Patent Office Library, 25 Southampton Buildings, Chancery Lane.
Pharmaceutical Society, 17 Bloomsbury Square.
Royal Geographical Society, 1 Saville Row.
Royal Institute of British Architects, 9 Conduit Street, Hanover Square.
Royal Institution of Great Britain, Albemarle Street, Piccadilly, W.
Royal Meteorological Society, 22 Great George Street, Westminster.
Royal Photographic Society, 5a Pall Mall, East.
Royal Society, Burlington House.
Royal Statistical Society, 9 Adelphi Terrace, Strand.
Society of Arts, John Street, Adelphi.
Society of Biblical Archæology, 37 Great Russell Street, Bloomsbury.

ENGLAND AND WALES—*continued.*

Society of Chemical Industry, Palace Chambers, 9 Bridge Street, Westminster.
Society of Engineers, 17 Victoria Street, Westminster.
Society of Psychical Research, 19 Buckingham Street.
Engineering. The Publisher, 35 Bedford Street, Strand.

Manchester—

Manchester Association of Engineers, Grand Hotel, Aytoun Street.
Geographical Society, 16 St. Mary's Parsonage.
Literary and Philosophical Society of Manchester, 36 George Street.

Middlesborough—

Cleveland Institution of Engineers.

Newcastle-upon-Tyne—

North-East Coast Institution of Engineers and Shipbuilders, 4 St. Nicholas Buildings.
North of England Institute of Mining and Mechanical Engineers, Neville Hall.

Oxford—

Bodleian Library.

Stratford (Essex)—

Essex Field Club. Passmore-Edwards Museum, Romford Road.

Truro—

Royal Institution of Cornwall.

Watford—

Hertfordshire Natural History Society and Field Club, Herga. D. Hill, Hon. Librarian.

Welshpool—

Powys Land Club. The Secretaries, Museum and Library, Salop Road.

FRANCE.

Bordeaux—

Société des Sciences Physiques et Naturelles.

Marseilles—

Faculté des Sciences de Marseille.

Paris—

École Polytechnique. The Director.
Observatoire Météorologique Central de Montsouris.

GERMANY.

Berlin—

Deutsche Chemische Gesellschaft.
Deutsche Kolonial Verein.
Königliche Preussische Akademie der Wissenschaften.

GERMANY—*continued.*

Bremen—
Geographische Gesellschaft.

Giessen (Hesse)—
Oberhessische Gesellschaft für Natur-und Heilkunde.

Griefswald (Prussia)—
Geographische Gesellschaft.

Halle (Prussia)—
Verein für Erdkunde.
Kaiserliche Leopoldino—Carolinische Deutsche Akademie der Naturforscher.

INDIA.

Calcutta—
Geological Survey of India.

IRELAND.

Belfast—
Belfast Naturalists' Field Club, Museum, College Square, North.
Natural History and Philosophical Society, Museum, College Square. North.

Dublin—
Royal Dublin Society, Leinster House.
Royal Irish Academy, 19 Dawson Street.
Trinity College Library.

ITALY.

Milan—
Reale Instituto di Lombardo di Scienze, Lettere, ed Arti.

JAPAN.

Tokio—
Imperial University of Tokio, Science College.
Imperial University of Tokio.

MEXICO.

Mexico—
Observatorio Astronómico Nacional de Tacubaya.
Sociedad Cientifica "Antonio Alzate."

NEW ZEALAND.

Wellington—
Colonial Museum.

NETHELANDS.

Amsterdam—
Académie Royale des Sciences à Amsterdam.

Harlem—
Société des Sciences à Harlem.

Leyden—
Kon. Nederlandisch Aardrijkskundig Genootschap.

NORWAY.

Christiania—
Kongelige Norske Frederiks Universitet.

ROUMANIA.

Bucharest—
Societatiĭ de Sciinte Fizice.

RUSSIA.

Kazan—
Imperial Kezan University.

St. Petersburg—
Académie Impériale des Sciences.
Russian Chemical Society of the University of St. Petersburg.

SCOTLAND.

Aberdeen—
Philosophical Society, 147 Union Street.

Edinburgh—
Advocates' Library.
Botanical Society of Edinburgh, Royal Botanic Garden.
Geological Society, 5 St. Andrew Square.
Highland and Agricultural Society of Scotland, 3 George IV. Bridge.
Royal Physical Society, 18 George Street.
Royal Scottish Geographical Society, Queen Street.
Scottish Meteorological Society, 122 George Street.
Royal Scottish Society of Arts, 117 George Street.
Royal Society, The Mound, Princes Street.

Glasgow—
Archæological Society, 88 West Regent Street.
Baillie's Institution Free Library, Miller Street.
Faculty of Physicians and Surgeons of Glasgow, 242 St. Vincent Street.
Geological Society, 207 Bath Street.
Glasgow and West of Scotland Technical College Library, 38 Bath Street.
Institution of Engineers and Shipbuilders in Scotland, 207 Bath Street.
Mitchell Library, Miller Street.
Natural History Society of Glasgow, 207 Bath Street.
Stirling's Public Library, Miller Street.

Hamilton—
Mining Institute of Scotland.
Public Library.

Kelso—
Berwickshire Naturalists' Club. Rev. George Gunn, Stickhill Manse.

SWEDEN.

Upsala—
Royal University Library.

Stockholm—
Kongliga Svenska Vetenskaps-Akademie.

UNITED STATES.

Austin (Texas)—
  Texas Academy of Science.

Baltimore—
  Johns Hopkins University.

Boston—
  American Academy of Arts and Sciences.
  Boston Society of Natural History.

Colorado Springs—
  Colorado Scientific Society.

Davenport (Iowa)—
  Academy of Natural Sciences.

Des Moines (Iowa)—
  Iowa Geological Survey.

Indianopolis (Ind.)—
  Indiana Academy of Science.

Lawrence (Kansas)—
  Kansas University Quarterly.

Madison—
  Madison Geological and Natural History Society.
  Washburn Observatory.

Newhaven (Conn.)
  Connecticut Academy of Arts and Sciences.

New York.
  American Geographical Society, 11 West Twenty-ninth Street.
  American Museum of Natural History, Central Park, Seventy-seventh Street.
  American Society of Civil Engineers, 220 West Fifty-seventh Street.
  New York Academy of Sciences, Columbia Uuiversity, West 116th Street.
  School of Mines, Columbia College. The Associate Editor.

Philadelphia—
  Academy of Natural Science of Philadelphia.
  Alumni Association, 1829 North Eighth Street.
  American Pharmaceutical Association.
  American Philosophical Society. The Hon. Secretaries, 104 South Fifth Street.
  Franklin Institute, 15 South Seventh Street.
  Numismatic and Antiquarian Society of Philadelphia.
  Wagner Free Institute of Science, corner of Seventeenth Street and Montgomery Avenue.

Rochester (N.Y.)—
  Rochester Academy of Science. Corresponding Secretary.

UNITED STATES—*continued.*

St. Louis—
  Academy of Science of St. Louis.
  Missouri Botanical Garden.

San Francisco (California)—
  California Academy of Sciences.

Topeka (Kansas)—
  Kansas Academy of Science.

Washington—
  Bureau of Education (Department of the Interior).
  Bureau of Ethnology.
  Smithsonian Institution.
  United States Geological Survey.
  United States National Museum (Department of the Interior).
  United States Naval Observatory.

LIST OF PERIODICALS.

(*Those received in exchange are indicated by an asterisk*).

WEEKLY.

Academy.
Architect.
Athenæum.
British Journal of Photography.
Builder.
Building News.
Chemical News.
Comptes Rendus.
Dingler's Polytechnisches Journal.
Electrical Review.
Electrician.
*Engineering.
English Mechanic.
*India-rubber and Gutta-percha and Electrical Trades Journal.
*Journal of the Society of Arts.
Journal of Gas Lighting.
La Nature.
Nature.
Notes and Queries.
*Pharmaceutical Journal.
Scientific American and Supplement.

FORTNIGHTLY.

Annalen der Chemie (Liebig's).
*Berichte der Deutschen Chemischen Gesellschaft.
Journal für Praktische Chemie (Erdmann's).
Zeitschrift fur Angewandte Chemie.

MONTHLY.

*American Chemical Journal.
Analyst.
Annalen der Physik und Chemie.
Annales de Chimie et de Physique.
Annales de l'Institut Pasteur.
Annales des Ponts et des Chaussées.
Annales des Sciences Naturelles. Botanique.
Annales des Sciences Naturelles. Zoologie.

MONTHLY—*continued.*

Annals and Magazines of Natural History.
Antiquary.
Beiblätter zu den Annalen der Physik and Chemie.
*British Refrigeration Review.
Bulletin de la Société Chimique de Paris.
Bulletin de la Société Géologique de France.
Bulletin de la Société Industrielle de Mulhouse.
*Bulletin Mensuel de l'Observatoire de Montsouris.
*Canadian Entomologist.
*Deutsche Kolonialzeitung.
*Feilden's Magazine.
*Geographical Journal.
Geological Magazine.
*John Hopkins University Circulars.
Journal de Pharmacie et de Chimie.
Journal of Botany.
*Journal of the Chemical Society.
*Journal of the Franklin Institute.
*Journal of the Photographic Society.
*Journal of the Society of Chemical Industry.
London, Edinburgh, and Dublin Philosophical Magazine.
*Monatsbericht der Königlich Preussischen Akademie der Wissenschaften zu Berlin.
Monthly List of Official and Parliamentary Papers.
Petermanns Mitteilungen.
Polytechnic Bibliothek.
*Proceedings of Royal Society of London.
*Proceedings of the Society of Biblical Archæology.
Revue Universelle des Mines.
*Royal Astronomical Society's Monthly Notices.
Sanitary Journal.
Science Abstracts.
*Science of Man.
Science Gossip.
*Scottish Geographical Magazine.
*Travel.
Zoologist.

QUARTERLY.

Annales des Mines.
Annals of Botany.
Annals of Scottish Natural History.
*Archives Nèerlandaises des Sciences Exactes et Naturelles.
*Bulletin of the American Geographical Society.
Economic Journal.
Forschritte der Mathematik.
Journal of Anatomy and Physiology.
*Journal of the Anthropological Institute of Great Britain.
*Journal of Manchester Geographical Society.
Journal of the Royal Agricultural Society of England.
Journal of the Royal Microscopical Society.
*Journal of the Royal Statistical Society.
*Journal of the Scottish Meteorological Society.
*Kansas University Quarterly.
Mind: a Quarterly Review of Psychology and Philosophy.
Quarterly Journal of Economics.
*Quarterly Journal of Geological Society.
Quarterly Journal of Microscopical Science.
*Quarterly Journal of Royal Meteorological Society.
Quarterly Journal of Pure and Applied Mathematics.
Reliquary and Illustrated Archæologist.
*School of Mines Quarterly.
*Sociedad Cientifica "Antonio Alzate."
Zeitschrift für Analytische Chemie.

ANNUALLY.

Association Française pour l'Avancement des Sciences.
Cantor's Vorlesungen über Geschichte der Mathematik.
Dictionary of National Biography.
Hazell's Annual.
Jahres-Bericht Chemischen Technologie.
L'Année Scientifique et Industrielle.
Murray's English Dictionary.
Œuvres Complètes de Laplace.
Œuvres Complètes de Cauchy.
Palæontographical Society's Publications.
Philosophical Transactions, Royal Society of London.
Ray Society's Publications.
Repertorium der Technischen Journal—Litterature.
Statesman's Year-Book.
Symons's British Rainfall.
Who's Who?
Wright's English Dialect Dictionary.

LIST OF MEMBERS

OF THE

PHILOSOPHICAL SOCIETY OF GLASGOW

FOR 1899-1900.

HONORARY MEMBERS.

(*Limited to Twenty.*)

WITH YEAR OF ELECTION.

FOREIGN.

	Rudolph Albert von Kölliker, Würzburg.	1860
	Ernst Heinrich Hæckel, Jena.	1880
	Georg Quincke, Heidelberg.	1890

AMERICAN AND COLONIAL.

	Robert Lewis John Ellery, F.R.A.S., Victoria, Australia.	1874
5	Thomas Muir, M.A., LL.D., F.R.S.S., L. and E., Superintendent General of Education, Cape Colony.	1892
	Professor S. P. Langley, LL.D., D.C.L., Secretary of the Smithsonian Institution, Washington, U.S.A.	1895

BRITISH.

	Sir Joseph Dalton Hooker, K.C.B., K.C.S.I., M.D., D.C.L., LL.D., F.R.S., The Camp, Sunningdale.	1874
	Herbert Spencer, care of Messrs. Williams & Norgate, 14 Henrietta Street, Covent garden, London.	1879
	Rev. John Kerr, LL.D., F.R.S., Glasgow.	1885
10	Sir George Gabriel Stokes, Bart., M.A., LL.D., D.C.L., F.R.S., Lensfield cottage, Cambridge.	1887
	F. Max Müller, M.A., Professor of Comparative Philology, University of Oxford, Norham gardens, Oxford.	1889
	The Right Hon. Lord Rayleigh, M.A., D.C.L., LL.D., *Sec.* R.S., London, Terling place, Witham, Essex.	1890
	The Right Hon. Lord Lister, LL.D., D.C.L., *P.*R.S., 12 Park crescent, Portland place, London, W.	1895
	Sir Archibald Geikie, LL.D., D.Sc., F.R.S., F.R.S.E., F.G.S., Director-General of the Geological Survey of the United Kingdom, 10 Chester terrace, Regent's park, London, N.W.	1895
15	The Right Hon. Lord Kelvin, G.C.V.O., LL.D., D.C.L., F.R.S., Largs.	1896

(*Ordinary Member, 1846 till 1896.*)

	James B. Russell, LL.D., M.D., 49 Braid road, Morningside, Edinburgh, *Honorary Vice President.*	1899

CORRESPONDING MEMBERS.

WITH YEAR OF ELECTION.

	A. S. Herschel, M.A., D.C.L., F.R.S., F.R.A.S., Hon. Professor of Experimental Physics in the Durham College of Science, Newcastle-on-Tyne; Observatory House, Slough, Bucks.	1874
	Thomas E. Thorpe, Ph.D., F.R.S., Professor of Chemistry in Royal College of Science, London.	1874
	John Aitken, F.R.S., F.R.S.E., Ardenlea, Falkirk.	1883
	Alex. Buchan, M.A., LL.D., F.R.S.E., F.R.S., Secretary to the Scottish Meterological Society, 122 George street, Edinburgh.	1883
5	James Dewar, M.A., F.R.S., F.R.S.E., M.R.I., Jacksonian Professor of Physics, University of Cambridge, and Professor of Chemistry in the Royal Institution of Great Britain, 1 Scroope terrace, Cambridge.	1883
	Stevenson Macadam, Ph.D., F.R.S.E., Lecturer on Chemistry, Surgeon's Hall, Edinburgh.	1883
	Joseph W. Swan, M.A., F.R.S., Lauriston, Bromley, Kent.	1883
	William Milne, M.A., B.Sc., F.R.S.E., Department of Public Education, Cradock, Cape Colony.	1894
	Richard Lodge, M.A., Professor of History in Edinburgh University.	1899

ORDINARY MEMBERS.

WITH YEAR OF ENTRY.

* *Denotes Life Members.*

	Adams, John, M.A., B.Sc., Rector F.C. Training College, Glasgow, 12 Holyrood crescent.	1899
	Adam, Stephen, 199 Bath street.	1896
	*Adam, Thomas, F.S.I., 27 Union street.	1892
	Adams, William, Makerstoun, Bearsden.	1891
5	Addison, W. H., Superintendent, Deaf and Dumb Institution.	1895
	*Agar, Thomas F. Argentine Consul-General, 7 Royal Bank place.	1896
	Aikman, C. M., M.A., D.Sc., F.R.S.E., F.I.C., F.C.S., 128 Wellington street.	1886
	Aikman, W. G., 12 Kingsborough gardens, Kelvinside.	1899
	Alexander, D. M., Marionville, Queen's drive.	1887
10	Alexander, G. W., M.A., 129 Bath street.	1893
	Alston, J. Carfrae, 27 James Watt street.	1887
	Anderson, Alexander, 157 Trongate.	1869
	Anderson, David Blyth, 18 Park circus.	1897
	Anderson, James, 168 George street.	1890
15	Anderson, John, 22 Ann street.	1884
	Anderson, J. B. Mackenzie, M.B., 42 Lansdowne crescent.	1895
	Anderson, R. T. R., 80 Seedhill rd., Paisley.	1889
	Anderson, Robert, 44 Albert drive, Crosshill.	1887
	Anderson, Robert, 76 Bath street.	1896
20	*Anderson, T. M'Call, M.D., Professor of Practice of Medicine in the University of Glasgow, 2 Woodside terrace.	1873
	*Anderson, William, 284 Buchanan street.	1890
	Anderson, W. F. G., 47 Union street.	1878
	*Annan, J. Craig, 234 Sauchiehall street.	1888
	Annandale, Charles, M.A., LL.D., 35 Queen Mary avenue.	1888
25	Arnot, James Craig, 162 St. Vincent street.	1869
	*Arnot, J. L., 116 West Campbell street.	1890
	Atkinson, J. B., 10 Foremount terrace, Partick.	1889
	Bain, Andrew, 17 Athole gardens.	1890
	Bain, Robert, 132 West Nile street.	1869
30	*Baird, J. G. A., M.P., Wellwood, Muirkirk.	1892
	Ballantine, George, jun., 100 Union street.	1897
	Balloch, Robert, Eamont lodge, Dowanhill.	1843
	Balmain, Thos., 1 Kew terrace, Kelvinside.	1881
	Barclay, A. J. Gunion, M.A., F.R.S.E., High School.	1893
35	Barclay, A. P., 133 St. Vincent street.	1890
	Barclay, George, 6 Colebrooke ter.	1891

Barclay, James, 16 Roxburgh street, Kelvinside. 1871

*Barr, Archibald, D.Sc., Professor of Civil Engineering and Mechanics in the University of Glasgow, Royston, Dowanhill, *Vice-President*. 1890

*Barr, James, C.E., I.M., F.S.I., 221 West George street. 1883

40 Barr, Thos., M.D., F.F.P.S.G., 13 Woodside place, W. 1879

Barrett, Francis Thornton, Mitchell Library. 1880

Bathgate, William, M.A., 13 Westbourne gardens. 1887

Bayne, Malloch A., 13 Kelvin drive, Kelvinside. 1878

Beatson, George T., B.A. (Cantab.), M.D., 7 Woodside crescent. 1881

45 Becker, L., Ph.D., Professor of Astronomy in the University of Glasgow, The Observatory. 1895

Begg, Wm., 636 Springfield road. 1883

Beilby, George T., F.I.C., St. Kitts, Slateford. 1895

*Beith, Gilbert, 15 Belhaven terrace. 1881

*Bell, Henry, Mynthurst, Reigate, Surrey. 1876

50 Bell, Sir James, Bart., 101 St. Vincent street. 1877

*Bell, James T., Northcote, Dowanhill. 1896

*Bell, John J., Northcote, Dowanhill. 1896

Bennett, Robert J., Alloway park, Ayr. 1883

Bergius, Walter, C.E., 77 Queen street. 1897

55 Bilsland, William, 28 Park circus. 1888

*Bishop, A. Henderson, Burncroft, Thorntonhall. 1896

Black, J. Albert, Duneira row. 1869

Black, Malcolm, M.D., 5 Canning place. 1880

*Blackie, J. Alexander, 17 Stanhope street. 1881

60*Blackie, J. Robertson, 17 Stanhope street. 1881

Blackie, W. G., Ph.D., LL.D., F.R.G.S., 1 Belhaven terrace, Kelvinside. 1841

*Blackie, Walter W., B.Sc., 17 Stanhope street. 1886

Blair, G. M'Lellan, 2 Lilybank ter. 1869

Blair, J. M'Lellan, Williamcraig, Linlithgowshire. 1869

65 Blair, Matthew, 5 Hampton Court terrace. 1887

Blyth, James, M.A., F.R.S.E., Professor of Natural Philosophy, Glasgow and West of Scotland Technical College, 204 George street. 1881

*Blyth, Robert, 1 Montgomerie quadrant. 1885

*Blythswood, The Rt. Hon. Lord, Renfrew, *President*. 1885

*Borland, William, 142 St. Vincent street. 1895

70 Borthwick, James D., 46 Balshagray avenue, Partick. 1891

Bottomley, James T., M.A., D.Sc., F.R.S., F.R.S.E., F.C.S., 13 University gardens, Hillhead. 1880

Bottomley, Wm., C.E., 15 University gardens. 1880

Bower, F.O., D.Sc., M.A., F.R.S., F.L.S., Regius Professor of Botany in the University of Glasgow, 45 Kersland terrace. 1885

Boyd, John, Shettleston Iron-works, near Glasgow. 1873

75 Brodie, Wm. Brodie, M.B., C.M., Muirhead Demonstrator of Physiology, University of Glasgow. 1897

Brown, Alex., The Craigs, Carmunnock. 1896

*Brown, Hugh, 5 St. John's terrace, Hillhead. 1887

Brown, James, 76 St. Vincent street. 1876

*Brown, John, 11 Somerset place. 1881

80 Brown, Robert, 19 Jamaica street. 1882

*Brown, Wm. Stevenson, 67 Washington street. 1886

*Brown, William, 165 West George street. 1892

Browne, Robert, B.Sc., 45 Washington street. 1893

Brownlie, J. Rankin, L.D.S.(Eng.), 220 West George street. 1892

85 Bruce, David, M.A., LL.B., 49 West George street. 1897

Buchan, David W., Fairy Knowe, Cambuslang. 1896

Buchanan, Alex. M., A.M., M.D., Professor of Anatomy, Anderson's College Medical School, 98 St. George's road. 1876

Buchanan, George S., 85 Candleriggs. 1845

*Buchanan, Wm., Enderley, Bearsden. 1886

90 Burnet, John, F.R.I.B.A., I.A., 167 St. Vincent street. 1850

Burnet, John James, A.R.S.A., F. R. I. B. A., 18 University avenue, 1892

Burns, J., M.D., 15 Fitzroy place, Sauchiehall street. 1864

Burton, Thomas John, M.D.(Ed.), Lonsdale, Bearsden. 1896

Burton, William L., Electrical Engineer, 6 Richmond crescent, Glasgow. 1899

95 Caird, Robert, LL.D., F.R.S.E., 56 Esplanade, Greenock. 1898
*Caldwell, George B., Scotia Leather Works, Boden street. 1892
Cameron, Sir Charles, Bart., M.P., M.D., LL.D., Greenock. 1870
Cameron, Sir Hector, M.D., Professor of Clinical Surgery, University of Glasgow, 200 Bath street. 1873
*Campbell, Arch., Springfield quay. 1895
100*Campbell, J. A., LL.D., M.P., Stracathro, Brechin. 1848
*Campbell, James, 137 Ingram st. 1885
*Campbell, John Ferguson, 2 Holborn terrace, N. Kelvinside, *Vice-President.* 1892
Campbell, John MacNaught, C.E., F.Z.S., F.R.S.G.S., Kelvingrove Museum. 1883
Campbell, Malcolm, 18 Gordon street. 1894
105*Campbell, Thomas, Maryhill Iron works. 1894
Carlile, William W., Hailie, Largs, Ayrshire. 1897
Carmichael, Neil, M.D., C.M., F. F. P. S. G., Invercarmel, 23 Nithsdale drive, Pollokshields. 1873
Carslaw, Horatio S., M.A., Assistant to the Professor of Mathematics, University of Glasgow. 1898
Carver, Thomas, A. B., B.Sc., C.E., 118 Napiershall street. 1890
110 Cassells, John, 154 Queen's drive, Crosshill. 1890
Cassells, Robert Dunlop, B.Sc., 62 Glencairn drive, Pollokshields. 1895
*Cayzer, Sir Charles W., M.P., 109 Hope Street. 1886
Chalmers, A. K., M.D., D.P.H. (Camb.), 7 Buckingham terrace. 1892
Chalmers, George, 13 Hamilton crescent, Partickhill. 1896
115 Chalmers, P. MacGregor, I.A., F.S.A.Scot., 95 Bath street. 1891
Chamen, W. A., Drumard, Partickhill road. 1898
Chisholm, James, 16 Knowe terrace, Pollokshields. 1899
*Chisholm, Samuel, Lord Provost of Glasgow, 20 Belhaven terrace. 1890
*Christie, Henry W., Levenfield house, Alexandria. 1892
120 Christie, John, Turkey-red Works, Alexandria, Dumbartonshire. 1868
*Christison, George, 13 Cambridge drive. 1897
Chrystal, W. J., F.I.C., F.C.S., Shawfield Works, Rutherglen. 1882
Clark, John, Ph.D., F.I.C., F.C.S., 138 Bath street. 1870
Clark, John, 9 Wilton crescent. 1872
125 Clark, John, M.A., 2 Kersland st., Hillhead. 1897
*Clark, William, 125 Buchanan st. 1876
*Cleland, John, M.D., LL.D., D.Sc., F.R.S., Professor of Anatomy in the University of Glasgow. 1884
*Cochran, Robert, 7 Crown circus, Dowanhill. 1877
Coghill, Wm. C., 263 Argyle street. 1873
130 Colville, James, M.A., D.Sc., 14 Newton place. 1885
*Combe, James Russell, 2 Royal crescent, Crosshill. 1895
Connell, Wm., Fairhill, Hamilton. 1870
Connell, William, jun., Coldstream, Cathkin road, Langside. 1897
Cooke-Taylor, R. W., West Lodge, Crown terrace. 1898
135 Copland, Wm. R., M.Inst.,C.E.,F.S.I., 146 West Regent street. 1876
Core, Wm., M.D., Medical Superintendent, Barnhill Hospital. 1891
Cormack, J. D., B.Sc., Lecturer in Electrical Engineering, University of Glasgow. 1898
Coste, Jules, French Consulate, 131 West Regent street. 1888
Costigane, John T., Limekilns house, East Kilbride. 1889
140 Costigane, William, Clifton hall, Albert drive, Pollokshields. 1890
Coubrough, A. Sykes, Parklea, Blanefield, Strathblane. 1869
Coulson, W. Arthur, 47 King street, Mile-end. 1888
Couper, James, Craigforth house, Stirling. 1862
Couper, Sinclair, Moore Park Works, Helen street, Govan. 1896
145 Cowan, M'Taggart, C.E., 53 Ashton terrace, Hillhead. 1876
Craig, T. A., C.A., 139 St. Vincent street. 1886
Cree, Thomas S., 21 Exchange square. 1869
Crichton, James, 201 Nithsdale road, Pollokshields. 1892
Crosbie, L. Talbot, Scotstounhill, Whiteinch. 1890
150 Cross, Alexander, M.P., 14 Woodlands terrace. 1887
*Crum, Walter G., Thornliebank. 1895
Crum, William G., Thornliebank. 1896
*Curphey, Wm. Salvador, Borva, Lenzie. 1883
Cuthbert, Alexander A., 14 Newton terrace. 1885
155*Cuthbertson, Sir John N., LL.D., 29 Bath street. 1850
Cuthbertson, Thomas W., M.A., 25 Blythswood square. 1897

*Daly, James, 2 Prince's gardens. 1898
Dalziel, J. Kennedy, M.B., C.M., 196 Bath street. 1896
Dansken, A. B., 105 West George street. 1877
160*Dansken, John, I.M., F.S.I., F.R.A.S., 241 West George street. 1876
Dempster, John, 7 Knowe terrace, Pollokshields. 1875
Dennison, William, C.E., 175 Hope street. 1876
*Dick, George Handasyde, 136 Buchanan street. 1887
*Dixon, A. Dow, 10 Montgomerie crescent, Kelvinside. 1873
165 Dixon, Walter, 59 Bath street. 1893
Dobbie, A. B., M.A., 24 West Cumberland street. 1885
Donald, John, 23 Queen Margaret drive, N. Kelvinside. 1872
Donald, William, J. A., 16 Lilybank gardens. 1877
Dougall, Franc Gibb, 167 Canning street. 1875
170 Downie, John, Burnawn, Uddingston. 1898
Downie, Robert, jun., Carntyne Dye-works, Parkhead. 1872
Downie, Thomas, Hydepark Foundry. 1886
*Dreghorn, David, Smith st., Kinning Park. 1896
*Duncan, Eben., M.D., C.M., F.F.P.S.G., Queen's Park house, Langside road, *Hon. Vice-President*. 1873
175 Duncan, Hugh, M.A., LL.B., 175 West George street. 1895
Duncan, J. A., Glenlee, Bridge of Allan. 1896
*Duncan, Robert, Whitefield Works, Govan. 1890
*Duncan, Walter, 137 W. George street. 1881
*Dunlop, Nathaniel, 25 Bothwell st. 1870
180 Dunn, Robert Hunter, 4 Belmont crescent. 1878
Dyer, Henry, M.A., D.Sc., C.E., 8 Highburgh terrace, Dowanhill. 1883

Edington, George Henry, M.D., M.R.C.S. (Eng.), 225 Bath street. 1896
*Edwards, John, Govanhaugh Dye-works, M'Neil street. 1883
Elgar, Francis, LL.D., F.R.S., 113 Cannon street, London, E.C. 1884
185 Elliot, G. F. Scott, M.A., B.Sc., F.L.S., F.R.G.S., Cedarhall, Kilmalcolm. 1896
Erskine, Jas., M.A., M.B., L.F.P.S.G., 351 Bath street. 1886
*Ewing, Wm., 45 Renfield street. 1883
Fairweather, Wallace, C.E., 62 St. Vincent street. 1880
Falconer, Patrick, 19 Kelvinside gardens. 1876
190 Falconer, Thos., 50 Kelvingrove st. 1880
Farquhar, John, 13 Belhaven ter. 1872
Farquhar, Wm. R., Marymar, Kilmalcolm. 1892
Fawsitt, Charles A., 9 Foremount terrace, Partick. 1879
*Fergus, Freeland, M.D., F.R.S.E., F.F.P.S.G., *Hon. Secy.*, 22 Blythswood sq. 1887
195*Fergus, Oswald, D.D.S., L.D.S., 12 Clairmont gardens. 1896
Ferguson, James, 18 Leven street, Pollokshields. 1897
*Ferguson, John, M.A., LL.D., F.R.S.E., Professor of Chemistry, University of Glasgow. *Hon. Vice-President*. 1869
Ferguson, John Forbes, 166 St. Vincent street. 1895
Fergusson, Alex. A., 48 M'Alpine st. 1847
200 Findlay, Joseph, Clairmont, Winton drive, Kelvinside. 1873
Finlayson, James, M.D., 2 Woodside place. 1873
*Fleming, James, 136 Glebe street. 1880
*Fleming, William James, M.D., 3 Woodside terrace. 1876
Foster, W. A., St. Catherines, Newlands road, Langside. 1899
205 Fotheringham, T. B., 52 Barrland street, Maxwell road. 1889
Foulis, William, C.E., 45 John st. 1870
*Fowler, John, 5 Derby street, Sandyford. 1880
Frame, James, 45 Keir street, Pollokshields. 1885
Fraser, Melville, 31 St. Vincent place. 1890
210*French, Thomas, 1 Kelvinside ter. 1897
Frew, Alex. C.E., 175 Hope street. 1876
*Frew, William, Ph.D., Wellpark Brewery. 1898
Fryers, Arthur John, Architect, 22 Bath street, Largs. 1899
*Fullerton, Robt., M.D., 24 Newton place. 1896
215 Fulton, James, The Glen, Paisley. 1897
Fulton, R. C., 14 Hamilton Park ter. 1890
Fyfe, Alexander, 38 Burnbank gardens. 1897
Fyfe, Henry B., 115 St. Vincent st. 1892
Fyfe, Leander M., F.E.I.S., Headmaster, Queen's Park School, Glasgow. 1899

220*Gairdner, C. D., C.A., 115 St. Vincent street. 1886
Gairdner, Sir W. T., K.C.B., M.D., LL.D., F.R.S., 225 St. Vincent st. 1863

Galbraith, Peter, 122 Wellington st. 1889
Galbraith, Walter M., 7 Holyrood crescent. 1893
Gale, James M., C.E., 45 John st. 1856
225 Galloway, T. Lindsay, C.E., 43 Mair street, Plantation. 1881
Galt, Professor Hugh, M.B., C.M., F.F.P.S.G., D.P.H.(Camb.), 14 Berkeley terrace, W. 1900
Gardner, Daniel, 36 Jamaica street. 1869
*Garrow, James R., 6 Pollok road. 1890
*Garroway, John, 694 Duke st. 1875
230 Gibson, Charles R., Lynton, Hawkhead, Paisley. 1895
Gibson, William, 2 Wilton mansions. 1896
Gilfillan, Wm., 129 St. Vincent st. 1881
Gillies, W. D., 17 Royal Exchange square. 1872
Glaister, John, M.D., F.F.P.S.G., D.P.H. (Camb.), F.R.S.E., F.C.S., &c., Professor of Forensic Medicine and Public Health, University of Glasgow, 18 Woodside place. 1879
235 Goldie, James, 52 St. Enoch square. 1883
Goodwin, Robert, 58 Renfield street. 1875
Gordon, Alexander James, 200-202 George street. 1898
Gow, J. R., 12 Renfield street. 1898
Gow, Leonard, 45 Renfield street. 1889
240 Gow, Leonard, jun., 45 Renfield st. 1884
Gow, Robert, 3 Victoria circus, Dowanhill gardens. 1860
*Graham, Robert, 108 Eglinton st. 1888
*Graham, William, B.L., 11 Claremont terrace. 1885
Gray, Andrew, 30 Bath street. 1889
245 Gray, Andrew, LL.D., F.R.S., Professor of Natural Philosophy in Glasgow University. 1899
Gray, James, M.D., 15 Newton terrace. 1863
Greig, James R., Claremont, Langside. 1897

Halket, George, M.D., F.F.P.S.G., 4 Royal crescent, W. 1889
*Hamilton, John, I.A., 212 St. Vincent street. 1885
250 Hamilton, Robert O., Victoria Grain Mills, West street, Kingston. 1898
Hanbidge, James E., 8 Balmoral crescent, Crosshill. 1897
Hannay, P. M., Bridge of Allan. 1898
Harris, David Fraser, M.D., B.Sc. (Lond.), F.R.S.E., F.S.A.(Scot.), Lecturer on Physiology in the University of St. Andrews, 6 Bell street, St. Andrews. 1897
Harvey, William Ure, Ornsay, Glenburn road, Bearsden. 1896
255 Harvie, William, 8 Bothwell terrace, Hillhead. 1888
Hassard, William John, 209 Sauchiehall street. 1895
Hedderwick, Maxwell, 22 St. Vincent place. 1892
*Henderson, A. P., 20 Newton place. 1880
Henderson, George G., M.A., D.Sc., F.I.C., F.C.S., Professor of Chemistry, Glasgow and West of Scotland Technical College, 204 George street. 1883
260*Henderson, John, Meadowside Works, Partick. 1879
Henderson, John, Towerville, Helensburgh. 1890
Henderson, Thomas Beath, M.D., 155 Bath street, Glasgow. 1899
*Henderson, William, 15 Cadogan st. 1873
Hendry, Geo. Scott, 87 Bothwell st. 1895
265 Henry, R. W., 9 Parkgrove ter., W. 1875
Heys, Zechariah J., South Arthurlie, Barrhead. 1870
Higgins, Henry, jun., 248 West George street. 1878
Hinshelwood, James, M.A., M.D., 9 Elmbank street. 1896
Hodge, William, 27 Montgomerie drive, Kelvinside. 1878
270 Hogg, Robert, 9 Nithsdale drive, Pollokshields. 1865
Holmes, Daniel T., B.A., Woodburn, Kilmalcolm. 1898
*Hope, James, 8 Dean house, Lenzie. 1898
Houstoun, Wm. Henry, Hillcrest, Cambridge drive. 1895
Howat, William, 37 Elliot street. 1885
275 Hunt, Edmund, 121 W. George st. 1856
*Hunt, John, Milton of Campsie. 1881
Hunter, the Rev. John, D.D., 9 University Gardens, Glasgow. 1899
Hunter, Walter K., M.D., 1 Newton terrace, Glasgow. 1899
*Hunter, Wm. S., 70 Robertson st. 1889
280 Hutchison, John C., 8 Lansdowne crescent. 1900
Hutchison, Peter, 3 Lilybank terrace, Hillhead. 1889
Hutton, James, C.A., 203 West George street.

Inglis, John, LL.D., Pointhouse Shipyard. 1895
Inglis, R. A., Culrain, Bothwell. 1889

285 Jack, William Robert, M.D., 43 Lansdowne crescent. 1899
*Jack, William, M.A., LL.D., Professor of Mathematics in the University of Glasgow. 1881
Jamieson, Andrew, F.R.S.E., M.Inst.C.E., M.Inst.E.E., etc., 16 Rosslyn terrace, Kelvinside. 1881

Johnston, David, 160 West George st. 1891
Johnston, George, Mosesfield, Springburn. 1896
290 Johnstone, Jas., Coatbridge street, Port-Dundas. 1869

Kay, Thomas, M.B., C.M., 5 Rosebery street. 1899
Kay, Wm. E., F.C.S., 47 Camphill street, Crosshill. 1887
Kean, James, 32 Scotia street, Garnethill. 1888
Kelly, Hugh, M.D., Catrine Bank, Shields road, Pollokshields. 1898
295 Kelly, James K., M.D., F.F.P.S.G., Park villa, Queen Mary avenue, Crosshill. 1889
Kemp, Wm. (Alexander, Fergusson, & Co., Ltd.), Ruchill, Maryhill. 1898
Kennedy, James, 33 Greendyke st. 1889
*Ker, Charles, M.A., C.A., 155 St. Vincent street. 1885
*Ker, Wm., 1 Windsor ter., West. 1874
300 Kerr, Adam, 175 Trongate. 1887
Kerr, Charles James, 44 West George street. 1877
Kerr, Geo. Munro, 97 Buchanan st. 1890
Kerr, John G., M.A., LL.D., 15 India street. 1878
Key, William, 109 Hope street. 1877
305 King, Sir James, Bart., LL.D., of Campsie, 115 Wellington street. 1855
King, John, Tigh Ruadh, Possilpark 1895
King, John C., 21 Newton place. 1898
Kirk, Robert, M.D., Newton cottage, Partick. 1877
Kirkpatrick, Alexander B., 88 St. Vincent street. 1885
310 Kirkwood, James, Carling lodge, Ibrox, 1890
Knight, James, M.A., B.Sc., F.C.S., F.G.S., F.E.I.S., The Shieling, Uddingston. 1893
* Knox, David J., 19 Renfield street. 1890

Laird, George H., 3 Seton terrace, Dennistoun. 1882
Laird, John, Marchmont, Port-Glasgow. 1876
315 Laird John, Royal Exchange Sale Rooms. 1879
Lamb, David, 3 Albion place, Dowanhill. 1896
Lamond, Robert, M.A., LL.B., 163 West George street. 1894
Lang, William, F.C.S., Crosspark, Partick. 1865
Lang, W. R., D.Sc., 9 Crown gardens, Glasgow. 1899
320 * Lauder, James, F.R.S.L., Glasgow Athenæum. 1892
*Lauder, John, 87 Union street. 1894
Law, John, R. K., 20 Ashton gardens, Dowanhill.
* Lindsay, Archd. M., M.A., 87 West Regent street. 1872
Lindsay, John, City Chambers, 1897
325 Long, William A. R. Jex, Larch Hill, Moffat. 1898
Lothian Alex. V., M.A., 11 Holborn terrace. 1893
Love, James Kerr, M.D., C.M., 10 Newark drive. 1888
Low, Isaac, 71 Stirling road. 1898
Lundholm, C. O., Nobel's Explosives Factory, Ardeer, Stevenston. 1890

330 M'Ara, Alexander, 65 Morrison st. 1888
M'Arly, Thomas, 29 West George street. 1897
MacArthur, J. G., Rosemary Villa, Bowling. 1874
* MacArthur, John S., 45 Renfield street. 1890
M'Callum, Robert, jun., 69 Union street. 1891
335 * M'Clelland, Andrew Simpson, C.A., 4 Crown gardens, Dowanhill. 1884
M'Conville, John, M.D., 27 Newton place. 1870
* M'Cowan, David, jun., 6 Eton gardens. 1898
M'Cracken, James, 5 Bowmont terrace, Kelvinside. 1889
M'Crae, John, 7 Kirklee gardens, Kelvinside. 1876
340 M'Creath, James, M.E., 208 St. Vincent street. 1874
M'Culloch, Hugh, 154 West Regent street. 1880
* M'Donald, David, 11 Huntly gardens, Kelvinside. 1897
* MacDonald, John, 72 Great Clyde street. 1896
M'Donald, Joseph, Wellpark Brewery, 1897
345 M'Dougall, Daniel Douglas, 2 Kingsborough gardens, Kelvinside. 1899
* Macfarlane, Walter, 12 Lynedoch crescent. 1885
M'Farlane, Wm., Edina lodge, Rutherglen. 1888
* M'Gilvray, R. A., 129 West Regent street. 1880
M'Houl, David, Ph.D., Dalquhurn Works, Renton, 1883
350 * Macindoe, Alex., 104 West George street. 1894
M'Kie, John, M.B., C.M., Florence bank, Springburn. 1899
Mackintosh, Donald J., M.B., C.M., Western Infirmary. 1894

Macintyre, John, M.B., C.M., 179 Bath street. 1895

M'Intyre, Wm., Marion bank, Rutherglen. 1888

355 M'Kellar, John C., 112 Bath st. 1896

M'Kellar, J., 25 Kelvinside terrace. 1893

* M'Kendrick, John G., M.D., C.M., LL.D., F.R.S., F.R.S.E., F.R.C.P.E., Professor of Physiology in the University of Glasgow, 2 Florentine gardens, *Hon. Vice-President.* 1877

* M'Kenzie, W. D., 43 Howard street. 1875

* MacKenzie, W. J., 8 Lindsay terrace, Partickhill. 1879

360 Mackinlay, David, 6 Great Western terrace, Hillhead. 1855

* Mackinlay, James Murray, 4 Westbourne gardens. 1886

M'Kissack, John, 68 West Regent street. 1881

Maclae, A. Crum, 147 St. Vincent street. 1884

M'Laren, Robert, Royal Bank, Garscube cross. 1898

365 M'Laren, William, 7 Westbank Quadrant, Hillhead. 1896

M'Laurin, Robert, 303 Main street, Maryhill. 1895

Maclay, W., Eildon villas, Mount Florida. 1893

M'Lean, Angus, B.Sc., C.E., Principal, Technical School, Paisley, 1897

Maclean, A. B., Craigpark Works, Dennistoun. 1899

370 Maclean, Magnus, M.A., F.R.S.E., D.Sc., Professor of Electrical Engineering, Glasgow and West of Scotland Technical College, 51 Kersland terrace, Hillhead. 1885

*MacLehose, James J., M.A., 61 St. Vincent street. 1882

*Macleod, A., 3 Dundas street. 1893

MacLellan, Lewis, 5 Bowmont gard. 1899

M'Millan, A. Lewis, M.D., C.M., 1 Rosebery ter., Gt. Western rd. 1897

375 M'Millan Archibald, Invermay, Balshagray, Partick. 1899

Macouat, R. B., 37 Elliot street. 1885

Macphail, Donald, M.D., Garturk cottage, Whifflet, Coatbridge. 1877

M'Vail, D. C., M.B., Professor of Clinical Medicine, St. Mungo's College, 3 St. James' terrace, Hillhead. 1873

Macwhannell, Ninian, 58 West Regent street. 1898

380 Machell, Thomas, 1 Burnbank ter. 1886

Main, Robert, B., 56 Dalziel drive. 1885

Malloch, A. M., Firhill, Garscube road. 1896

Mann, John, C.A., 137 West George street, *Hon. Treasurer.* 1856

Mann, John, jun., M.A., C.A., 9 Woodlands terrace, W. 1885

385 Mann, Ludovic MacLellan, 137 West George street. 1897

Manwell, James, The Hut, 4 Albert drive, Pollokshields. 1876

Marr, Hamilton Clelland, M.D., Woodilee Asylum, Lenzie. 1899

Marshall, T. Rhymer, D.Sc., Professor of Chemistry in St. Mungo's College, 19 Sandyford place. 1894

Martin, Jas. F., 63 Brunswick st. 1895

390 Martin, Robert, 8 Burnbank terrace, W. 1897

Marwick, Sir J. D., LL.D., F.R.S.E., 19 Woodside terrace. 1878

Mathie, George M., 15 Dunard road, Rutherglen. 1895

Mathieson, J. H., 3 Grosvenor ter., Kelvinside. 1896

Mathieson, T. O., 3 Grosvenor ter. 1896

395 Mavor, Henry A., 47 King street, Mile-end. 1887

Mavor, Samuel, 37 Burnbank gard. 1890

May, A. H., 1 Crown circus, Dowanhill. 1898

Mayer, John, Strathview, Cathkin road, Langside. 1860

Mechan, Arthur, 60 Elliot street. 1876

400 Mechan, Henry, 60 Elliot street. 1879

Menzies, Thos., Hutchesons' Grammar School, Crown street. 1859

Menzies, William Crawford, City Improvement Trust, 34 Trongate. 1895

Millar, James, 158 Parliamentary rd. 1870

Miller, A. Lindsay, 122 Wellington street. 1878

405 Miller Alexander, jun., Broomhill, Partick. 1899

*Miller, Arch. Russell, Castlebank, Bothwell. 1884

Miller, Major, David S., 8 Royal crescent, W. 1887

*Miller, George, Winton drive, Kelvinside. 1881

Miller, G. J., Frankfield, Shettleston. 1888

410* Miller, Thos. P., Cambuslang Dyeworks. 1864

Mills, Edmund J., D.Sc., F.R.S., "Young" Professor of Technical Chemistry, Glasgow and West of Scotland Technical College, 60 John street. 1875

Mirrlees, James B., Redlands, Kelvinside. 1866

*Mirrlees, William J., 45 Scotland st. 1889

Mitchell, Andrew, C.A., The Glasgow District Subway Co., Factor and Treasurer's Office, St. Enoch square Station. 1896

415*Mitchell, George A., 5 West Regent street. 1883
Mitchell, Nelson, 3 Great Western terrace. 1898
Mitchell, Wm. James, M.A., B.L., 49 West George street. 1897
Mitchell, J. O., LL.D, 7 Huntly gardens. 1899
*Moffatt, Alexander, 23 Abercromby place, Edinburgh. 1874
420 Mollison, James, 6 Hillside gardens, Partick. 1889
*Mond, Robert Ludwig, B.A. (Cantab.), F.R.S.E., 20 Avenue road, Regent's park, London, N.W. 1890
*Monro, T. K., M.A., M.D., F.F.P.S.G., 10 Clairmont gards. 1897
*Monteith, Robert, Greenbank, Dowanhill gardens. 1885
Moore, Alexander, C.A., 50 Montgomerie drive, Kelvinside. 1869
425 Moore, Alexander George, M.A., B.Sc., 13 Clairmont gardens. 1886
Morrice, Jas. A., 1 Prince's ter., Dowanhill. 1883
Motion, James Russell, 38 Cochrane street. 1887
Motion, Thomas Mason, 6 Blythswood drive. 1897
Muir, Alex., 400 Eglinton street. 1883
430*Muir, Allan, Ardmay, Newlands road, Langside. 1881
Muir, Sir John, Bart., 22 West Nile street. 1876
Muir, Robert, M.D., F.R.C.P.E., Professor of Pathology in Glasgow University, 4 Alfred terrace, Hillhead. 1899
*Muirhead, Andrew Erskine, Cart Forge, Crossmyloof. 1873
Muirhead, James, 2 Bowmont gardens, Kelvinside. 1887
435*Muirhead, Robert F., M.A., B.Sc., 24 Kersland street, Hillhead. 1879
Munro, Daniel, F.S.I., 10 Doune terrace, Kelvinside. 1867
Munro, J. M. M., M.Inst. E.E., M.Inst.C.E., F.R.S.E., 136 Bothwell street. 1896
Munsie, George, 109 Virginia place. 1871
Munsie, Robert George, 109 Virginia place. 1883
440 Murdoch, George, 40 St. Vincent place. 1894
*Murdoch, Robert, 91 Maxwell road. 1880
*Murray, Daniel, 4 Eastpark terrace, Maryhill. 1896
*Murray, David, LL.D., 169 West George street. 1876
Murray, John Bruce, 24 George square. 1890
445 Napier, Alex., M.D., F.F.P.S.G., Rose Bank, Queen Mary avenue, Crosshill. 1886
*Napier, John, Audley mansions, Grosvenor square, London. 1849
Napier, Robert T., 75 Bothwell street, Glasgow. 1899
*Neilson, George, 34 Granby ter. 1897
*Neilson, James, 116 Bishop street, Port-Dundas. 1896
450 Nelson, Alex., 80 Gordon street. 1880
Neilson, William, 95 Findlay Drive, Dennistoun, Glasgow. 1899
*Newlands, Joseph F., 28 Renfield street. 1883
Nicoll, James H., M.B., 4 Woodside place. 1897
Nish, Robert, 9 Claremont terrace. 1897

455 Orr, Robert, 79 West Nile street. 1890
*Osborne, Hugh, Merchant, 4 Kew terrace, Glasgow. 1899
Osborne, Robert, 4 Huntly gardens. 1890

Park, James, 51 Milburn street. 1877
Park, Robert, M.D., 40 Grant st. 1894
460 Parker, Edward H., 11 Strathmore gardens, Hillhead. 1897
*Parker John Dunlop, C.E., 146 West Regent street. 1889
*Parnie, William, 27 Union street. 1897
*Paterson, Robert, C.A., 28 Renfield street. 1881
Paton, James, F.L.S., Corporation Galleries and Kelvingrove Museum. 1876
465 Patrick, Joseph, M.A., C.A., 203 West George street. 1893
Patterson, T. L., F.C.S., Maybank, Finnart street, Greenock. 1873
Peacock, T. Reid, 122 Wellington street. 1898
Peck, James W., M.A., Arnott Demonstrator in Natural Philosophy, Glasgow University, Broomhill Farm House, Partick. 1899
Petrie, Alexander, I.A., 134 Wellington street. 1885
470 Pirie, John, M.D., 26 Elmbank cres. 1877
*Pirrie, Robert, 9 Buckingham ter. 1875
Pollock, A. Barr, 3 Belgrave terrace, Hillhead. 1897
*Pollock, R., M.B., C.M., F.F.P.S.G., Laurieston house, Pollokshields. 1883
*Provan, James, 40 West Nile st. 1868
475*Provand, A. D., M.P., 2 Whitehall court, London, S.W. 1888

Raalte, Jacques Van, Baltic Chambers, 50 Wellington street. 1884
Ramsay, William, 146 Blythswood Drive, Glasgow. 1899

Ramsey, Robert, 14 Park terrace. 1889
*Ramsey, Robert, jun., 14 Park terrace. 1898
480 Rankine, David, C.E., 238 West George street. 1875
Rattray, Rev. Alex., M.A., Parkhead Parish, 4 Westercraigs, Dennistoun. 1879
Rattray, William A., 233 Hope st. 1890
Reid, David, 16 Cambridge street. 1887
*Reid, Hugh, Belmont, Springburn. 1880
485 Reid, James, 15 Montgomerie crescent. 1886
Reid, Thos. M.D., LL.D., 11 Elmbank street. 1869
Reid, William, M.A., 61 Grant st. 1881
*Reid, William L., M.D., 7 Royal crescent, West. 1882
Reith, Rev. George, M.A., D.D., Free College Church, 37 Lynedoch street. 1876
490 Renton, James Crawford, M.D., L.R.C.P. & S.Ed., 1 Woodside terrace. 1875
Rey, Hector, B.L., B.Sc., 2 Ailsa terrace. 1889
Richmond, Thos., L.R.C.P.E., 22 Holyrood crescent. 1887
Ritchie, Geo., Parkhead Forge and Steel Works. 1890
Robb, John, Busby house, Busby. 1897
495 Robertson, John, Woodside school, Endcliffe, Langside, *Hon. Lib.* 1860
Robertson, J. M'Gregor, M.A., M.B., C.M., 26 Buckingham ter., Hillhead. 1881
Robertson, Mure, M.E., 4 Clairmont gardens. 1897
Robertson, Robert H., Clyde bank, Rutherglen. 1888
Robertson, William, C.E., 123 St. Vincent street. 1869
500 Roberton, William, 209 Sauchiehall street, Glasgow. 1899
Rodger, Anderson, Glenpark, Port-Glasgow. 1899
*Rogers, John C., 224 St. Vincent street. 1888
Rose, Alexander, Richmond house, Dowanhill. 1879
*Ross, David, M.A., B.Sc., LL.D., E.C. Training College. 1888
505 Ross, Henry, 7 Park quadrant. 1876
*Ross, John, 9 Westbourne gardens. 1885
Ross, John Munn, C.A., 115 Wellington street. 1894
Ross, William, 10 Regent place, Shawlands. 1893
*Rottenburg, Paul, 105 West George street, *Vice-President.* 1872
510 Rowan, James, 22 Woodside place. 1897
Rowan, W. G., 234 W. George street. 1881
Rule, Robert, Jun., 7 Montgomerie crescent, Kelvinside. 1899
Rundell, R. Cooper, Underwriters' Room, Royal Exchange. 1877

Salmon, W. Forrest, F.R.I.B.A., 53 Bothwell street. 1870
515 Sawers, William D., Assoc.I.C., 70 Barrington Drive. 1894
Sayers, William Brooks, M.I.E.E. 189 St. Vincent street. 1890
Schmidt, Alfred, 508 New City rd. 1881
Scott, Alex., 34 Lawrence street, Dowanhill. 1871
*Scott, D. M'Laren, 2 Park quad. 1881
520 Scott, John, 245 Sauchiehall street. 1892
Scott, Robt., I.M., 155 Wellington street. 1884
Scougal, Andrew E. M.A., 14 Kelvin Drive, Kelvinside, N. 1899
Seligmann, Hermann L. 59 St. Vincent street. 1850
Sexton, A. Humboldt, F.C.S., F.I.C., F.R.S.E., Professor of Metallurgy, Glasgow and West of Scotland Technical College, 204 George street. 1892
525 Shanks, John Cochrane, 26 West Nile street. 1899
Simons, Michael, 206 Bath street. 1880
Simpson, J.C., M.D., 9 Marlborough terrace, Kelvinside. 1896
Sinclair, Alexander Ajmere lodge, Langside. 1883
Sinclair, John, 150 Buchanan st. 1898
530 Sloane, F. N., C.A., 187 West George street. 1893
Smart, William, M.A., LL.D., Professor of Political Economy, University of Glasgow, Nunholm, Dowanhill. 1886
Smellie, George, I.M., 167 St. Vincent street. 1880
*Smellie, Thos. D., F.S.I. 209 St. Vincent street. 1871
Smith, D. Johnstone, C.A., 149 W. George street. 1888
535 Smith, Hugh C., 55 Bath street. 1861
*Smith J. Guthrie, 54 West Nile st. 1875
*Smith, Robert B., Bonnybridge, Stirlingshire. 1884
*Smith, W.B., 31 Queen street. 1895
Snodgrass, William, M.A., M.B., C.M., 11 Victoria cres., Dowanhill. 1890
540 *Somerville, Alex., B.Sc., F.L.S., 4 Bute mansions, Hillhead. 1888
Sorley, Robert, 3 Buchanan st. 1878
*Spencer, Charles L., Edgehill, Kelvinside. 1891

*Spencer, J. J., Edgehill, Kelvinside. 1895
Spens, John A., 169 W. George st. 1879
545 *Steel, William Strang, Philiphaugh, Selkirk. 1889
*Stephen, John, Domira, Partick. 1880
Steuart, Daniel Rankin, Osborne cottage, Broxburn, West Lothian. 1877
Steven, Alexander Kay, Westmount Kelvinside 1897
*Steven, Hugh, Westmount, Montgomerie drive. 1869
550 Steven, John, 32 Elliot Street. 1875
Steven, J. H., Westmount, Kelvinside. 1897
*Stevenson, D. M., 12 Waterloo street. 1889
*Stevenson, Jas., F.R.G.S., 23 West Nile street. 1870
Stevenson, John, 41 Albert terrace, Trinity, Edinburgh. 1892
555 Stevenson, Robert, M.D. Labrador, Innellan. 1898
Stevenson, Wm., 13 Carlton place. 1888
Stewart, Andrew, 41 Oswald street. 1887
Stewart, Archibald, Marnock villa, Queen's Drive Crosshill. 1892
Stewart, David, 3 Clifton place. 1856
560 Stewart, John, 220 Parliamentary road. 1896
Stewart, Robert, Newark, Partick. 1899
Stewart, Walter, Jun., M.A., B.Sc., Chief Assistant to the Professor of Natural Philosophy, Glasgow University, Gartsherrie, Coatbridge. 1899
*Stobo, Thomas, Somerset house, Garelochhead. 1884
Stockdale, H. F., Clairinch, Milngavie. 1899
565 Stockman, Ralph, M.D., F.R.S.E., Professor of Materia Medica, The University of Glasgow. 1897
Stoddart, James Edward Howden Mid-Calder, N.B. 1872
Story, The Very Rev. R. H., D.D., Principal of the University of Glasgow. 1899
Strachan, R.U., Sheriff-Substitute, 9 Crown terrace. 1896
*Strain, John, C.E., 154 W. George street. 1876
570 Strathie, David C.A., 162 St. Vincent street. 1895
*Sutherland, David, Royal Marine Hotel, Nairn. 1880
*Sutherland, John, Great Western Hotel, Oban. 1880
Sutherland, J. R., C.E., 45 John street. 1884
Swan, Charles C., 15 Rose street, Garnethill. 1891
575 Symington, Thomas, Solicitor, 94 Hope street. 1896
Tatlock, John, F.I.C., 13 Parkgrove terrace, West, Sandyford. 1875
Tatlock, Robt. R., F.R.S.E., F.I.C., F.C.S., 156 Bath street. 1868
Taylor, Benjamin, F.R.G.S., 10 Derby crescent, Kelvinside. 1872
*Teacher, John H., M.B., C.M., 32 Huntly gardens. 1898
580 Teague, Francis, M.I.E.E., Electric Lighting Station, Paisley, 1894
Temple, Edwin, B.A.Cantab., Rector of Glasgow Academy. 1899
Tennant, Sir Charles, Bart., 195 West George street. 1868
Tennent, Gavin, P., M.D., 195 Bath street. 1875
Thom, R. Wilson, 8 Woodside terrace, 1898
585 Thomas, Moses, M.D., Superintendent, Royal Infirmary. 1890
Thomson, David, I.A., F.R.I.B.A., 2 West Regent street. 1869
Thomson, George C., F.C.S., 4 The Green, Bromborough Pool, near Birkenhead. 1883
Thomson, Gilbert, M.A., C.E., 164 Bath street. 1885
Thomson, Samuel M., M.A., 208 West George street. 1900
590 Thomson, G. R., B.Sc., 204 George street. 1895
*Thomson, James, F.R.I.B.A., 88 Bath street. 1886
*Thomson, James M., Glen Tower, Kelvinside. 1892
Todd, John Aiton, B.L., 115 St. Vincent street. 1897
Townsend, C. W., Crawford street, Port-Dundas. 1890
595 Trotter, John, 28 Gordon street. 1899
*Tullis, David, St. Ann's Leather Works, Bridgeton. 1894
*Tullis, James Thomson, Anchorage, Burnside, Rutherglen. 1883
*Turnbull, John, junr., M.I.M.E., 18 Blythswood square. 1883
Turnbull, Robert, 122 Wellington street. 1895
600 Turner, William, Barnfrow, Helensburgh. 1875
Turpie, John, 339 Sauchiehall street. 1896

Ure, William P., Regent Mills, Sandyford. 1893

Walker, Adam, 26 Newton place. 1880
*Walker, Archibald, M.A. (Oxon.), F.I.C., F.C.S., 8 Crown terrace, Dowanhill. 1858
605 Walker, James A., 300 St. Vincent street. 1898

Walker, J. W. O., 63 Montgomerie street, Kelvinside. 1896
*Wallace, Hugh, Bank of Scotland, 544 St. Vincent street. 1879
Wallace, R. Hedger, 3 St. Clair terrace, Morningside drive, Edinburgh. 1897
*Wallace, Wm., M.A., M.B., C.M., 25 Newton place. 1888
610 Warren, John A., C.E., 115 Wellington street. 1887
Watkinson, Wm. H., Whit. Sch., M.Inst.,Mech.E., Professor of Steam and Steam Engines in the Glasgow and West of Scotland Technical College, The Pines, Crookston. 1893
Watson, Archibald, 5 Westbourne terrace. 1881
Watson, James, 6 Kirklee Road, Kelvinside, W. 1873
*Watson, John, 205 West George street. 1886
615 Watson, Joseph, 225 West George street. 1882
*Watson, J. Robertson, M.A., Professor of Chemistry, Anderson's College Medical School, Dumbarton road. 1891
*Watson, Thomas Lennox, I.A., F.R.I.B.A., 166 Bath street. 1876
Watson, William, Gartmore, Langside. 1897
*Watson, William W., 5 Westbourne terrace. 1899
620 Welsh, John M., Ph.D., F.E.I.S., F.R.G.S., 115 Ledard road, Langside. 1897
Welsh, Thomas M., 3 Prince's gardens, Dowanhill. 1883
Wenley, James A., 5 Drumsheugh gardens, Edinburgh. 1870
Westlands, Robert, 4 Dixon street. 1869
Whyte, A. C., L.D.S., 42 Dundas street. 1892
625 White, John, Scotstoun Mills, Partick. 1897
Whitelaw, William, Hope Cottage, Crookston. 1897
*Whitson, Jas., M.D., F.F.P.S.G., 13 Somerset Place. 1882
Wield, John, 9 Barns street, Ayr. 1895
Williamson, John, 65 West Regent street. 1881
630 Wilson, Alex., Hydepark Foundry, 54 Finnieston street. 1874
*Wilson, David, M.A., D.Sc., F.C.S., Carbeth, Killearn. 1898
Wilson, William, Virginia buildings. 1881
Wilson, Wm., F.E.I.S., Schoolhouse, Pavenham, Bedford. 1889
Wingate, Arthur, 10 Prince's gardens, Dowanhill. 1882
635 Wingate, Walter E.., 4 Bowmont ter. 1880
Wood, James, M.A., Glasgow Academy. 1885
*Wood, Wm. Jas., 38 Cochrane street. 1899
*Workman, Chas., M.D., F.F.P., & S.G., Professor of Pathology, St. Mungo's College, 5 Woodside terrace. 1898
Wright, Robert Patrick, Professor of Agriculture, West of Scotland Agricultural College, 60 John st. 1895

640 Yellowlees, D., M.D., LL.D., Physician-Superintendent, Gartnavel. 1881
Young, Alfred A., M.A., M.B., 10 Hamilton Park terrace. 1899
Young, John, 2 Montague terrace, Kelvinside. 1885
Young, John, 88 Renfield street. 1881
*Young, John, jun., M.A., B.Sc., 61 Clyde street, Anderston. 1887
645 *Young, Thos. Graham, Westfield, West Calder. 1880
Younger, George, 166 Ingram street. 1847

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